Bay Area Air Quality Management District

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Staff Report

Proposed Amendments to Regulation 8, Rule 28: Episodic Releases from Pressure Relief Devices at Petroleum Refineries and Chemical Plants

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I. EXECUTIVE SUMMARY

This Staff Report outlines the rule development efforts by the Staff of the Bay Area Air Quality Management District with regard to pressure relief devices at petroleum refineries and chemical plants, which are subject to District Regulation 8, Rule 28. The Staff Report provides the technical analysis and policy rationale behind the proposed amendments to Regulation 8, Rule 28.

Pressure relief devices, or "PRDs", are safety devices used to protect pressurized equipment from overpressures caused by upset conditions. If equipment experiences an upset, the PRD will allow any excess pressure to be vented rather than building up and potentially causing a rupture or other catastrophic failure. The District committed in Further Study Measure 8 in the 2001 Ozone Attainment Plan to examining these devices to determine if hydrocarbon emissions from petroleum refineries could be further reduced by requiring additional controls on refinery PRDs.

To fulfill the commitment of Further Study Measure 8, District staff has reviewed the performance of Regulation 8, Rule 28. This review has shown that in general the current rule has been very effective. The Rule aims to phase out all atmospheric PRDs[i] eventually by requiring them to be routed to a control system (such as a safety flare or vapor recovery system) when new equipment is installed or when existing equipment is modified. The Rule also targets existing "bad actor" PRDs that have demonstrated a propensity for repeated releases, and requires them to be controlled immediately. Finally, for all PRDs, the Rule requires facilities to implement Prevention Measures designed to prevent or minimize releases.

The rule has resulted in a significant reduction in PRD emissions. When the current Rule was adopted in 1997, emissions from PRDs were found to be approximately 27 to 150 tons per year. Since the current rule has been in place, emissions have averaged 18 tons per year. Furthermore, since the rule's requirement to implement Prevention Measures took effect, emissions have averaged only 8.6 tons per year.

Notwithstanding these successes, staff has identified several areas where the current rule could be improved. The rule requires that facilities report releases over 10 pounds to the District, but it does not explicitly require emissions monitoring or set standards for monitoring equipment. As a result, some facilities are not monitoring their PRDs well, and have the potential for releases to go undetected. In addition, the rule is somewhat ambiguous about what "sources" it covers, and has some other undefined terms and ambiguous or unclear language. Staff is proposing that the Board of Directors adopt amendments to the current rule to address these issues.

[i] Atmospheric pressure relief devices (PRDs) vent directly to the atmosphere. Many PRDs vent to containment and processing such as a gas recovery system, to a thermal oxidizer, or to a flare.

Beyond these proposals, staff also considered whether it would be reasonable and appropriate to require refineries to control all existing atmospheric PRDs now, rather than waiting for them to be phased out over time as equipment is modified or replaced, as the current rule requires. Staff has found that such a requirement be prohibitively costly, with refineries having to incur costs of over $1 million per ton of emissions prevented, which is orders of magnitude greater than what the District normally considers cost-effective. Staff is therefore not recommending additional controls beyond those already required in the rule.

Finally, Staff also examined whether the District should require all PRDs to be vented to control systems as a safety measure to reduce the chance of accidental releases of acutely hazardous materials. Such industrial safety issues were not part of the mandate of Further Study Measure 8, which was aimed at reducing emissions of ozone precursors. Staff nevertheless investigated them because of a strong concern for worker and community safety. Staff found that a comprehensive overlapping web of industrial safety laws and regulations already exists, which requires operators to "design and maintain a safe facility taking such steps as are necessary to prevent releases," in the language of the federal Clean Air Act. Staff believes that additional District regulation in the area of process safety would be duplicative of existing regulations and would not be well directed towards reducing community and worker risks. This conclusion reaffirms the determination of the Board of Directors' Ad Hoc Committee on Accidental Emissions in connection with the adoption of the current rule that additional District requirements aimed at process safety would not be appropriate in Regulation 8, Rule 28. Safety at petroleum refineries and chemical plants is a high priority, however, and the District will continue to consult with local authorities to assure that adequate regulatory safeguards are in place.

Summary of Proposed Amendments:

Based on this review, staff proposes the following amendments to Regulation 8, Rule 28:

1. Require facilities to ensure that they have the capability to detect and quantify all release events, including small releases of 10 pounds (the reporting threshold), and require facilities to demonstrate this capability to the District;
2. Require data recording and recordkeeping for venting and emissions verification;
3. Clearly define the equipment subject to the rule as the process unit to ensure that the original intent of the rule – to regulate all PRDs on an individual source (i.e., process unit) in the same manner – is clarified;
4. Require facilities to report to the District their analysis of the root causes and potential corrective actions after each PRD release event;

5. Make minor, non-substantive changes to the rule such as deleting obsolete references to "turnarounds," moving requirements where appropriate, and clarifying various sections of the rule.

Rule Development Process:

During this rulemaking effort, staff hosted two technical workgroup meetings, as well as a public workshop in Rodeo, a community adjacent to a refinery. Staff also met informally with representatives of refineries, chemical plants, community groups, the Western States Petroleum Association and Contra Costa County Health Services. Staff has considered this public input and has incorporated it into the proposed amendments, where appropriate.

Economic Analysis:

The proposed amendments are aimed primarily at improving the clarity and enforceability of the current rule. They do not add additional substantive requirements or require the addition of new control equipment. The proposed amendments thus will not impose any significant additional costs on affected facilities beyond what is required under the current rule. Some facilities may not currently have adequate monitoring equipment to satisfy the rule's requirements, in part because those requirements are not explicitly spelled out in the current rule. Such facilities may have to install additional monitoring equipment to do so, but these are not costs imposed by the proposed amendments, and in any case they are expected to be minimal.

Environmental Impacts:

Pursuant to the California Environmental Quality Act (CEQA), the District has had an initial study for the proposed amendments prepared by Environmental Audit, Inc. The initial study indicated there are no potential significant adverse environmental impacts associated with the proposed amendments. Staff is proposing that the Board of Directors adopt a CEQA Negative Declaration for the proposed amendments.

Conclusions:

The proposed amendments will ensure that all facilities have the capability to detect PRD releases. They will also clarify the rule so that it can be more easily understood and enforced. Additional costs to affected facilities will be minimal. Staff therefore recommends that the Board of Directors adopt the proposed amendments along with the CEQA Negative Declaration.

II. BACKGROUND

Pressure relief devices are a means to safely relieve excessive pressures to prevent process equipment, piping, and other components from rupturing or causing other safety hazards. PRDs are designed to vent, or "lift", at a prescribed "set pressure" to relieve excess pressure before it can exceed safe

operating and/or equipment design levels. In new refinery construction, PRDs in VOC service must relieve to a control system that recovers the process gases or routes them to a disposal system such as a safety flare or thermal oxidizer. However, many older installations still have PRDs that vent directly to the atmosphere, resulting in the emission of VOCs and/or other material when the PRDs lift or if the valves leak at pressures below the set point. These PRDs are called "atmospheric" PRDs and are the subject of Regulation 8, Rule 28.

A. Types of Pressure Relief Devices

PRDs can be classified into the following general categories:

Pressure Relief Valves: The basic pressure relief valve must open automatically and quickly during a rise in system pressure beyond a specified set pressure, must close with minimal leakage when normal operating pressure is restored, and must be highly reliable. A pressure relief valve typically consists of a valve inlet or nozzle mounted on the pressurized system, a disc held against the nozzle to prevent flow under normal operating conditions, a spring to hold the disc closed, and a body/bonnet to contain the operating elements.[1] The spring load is adjustable to vary the pressure at which the valve will open. This design is illustrated in Figure 2.1.[2] Figure 2.2 is a photo of pressure relief valves.

Figure 2.1
Spring-Loaded Pressure Relief Valve

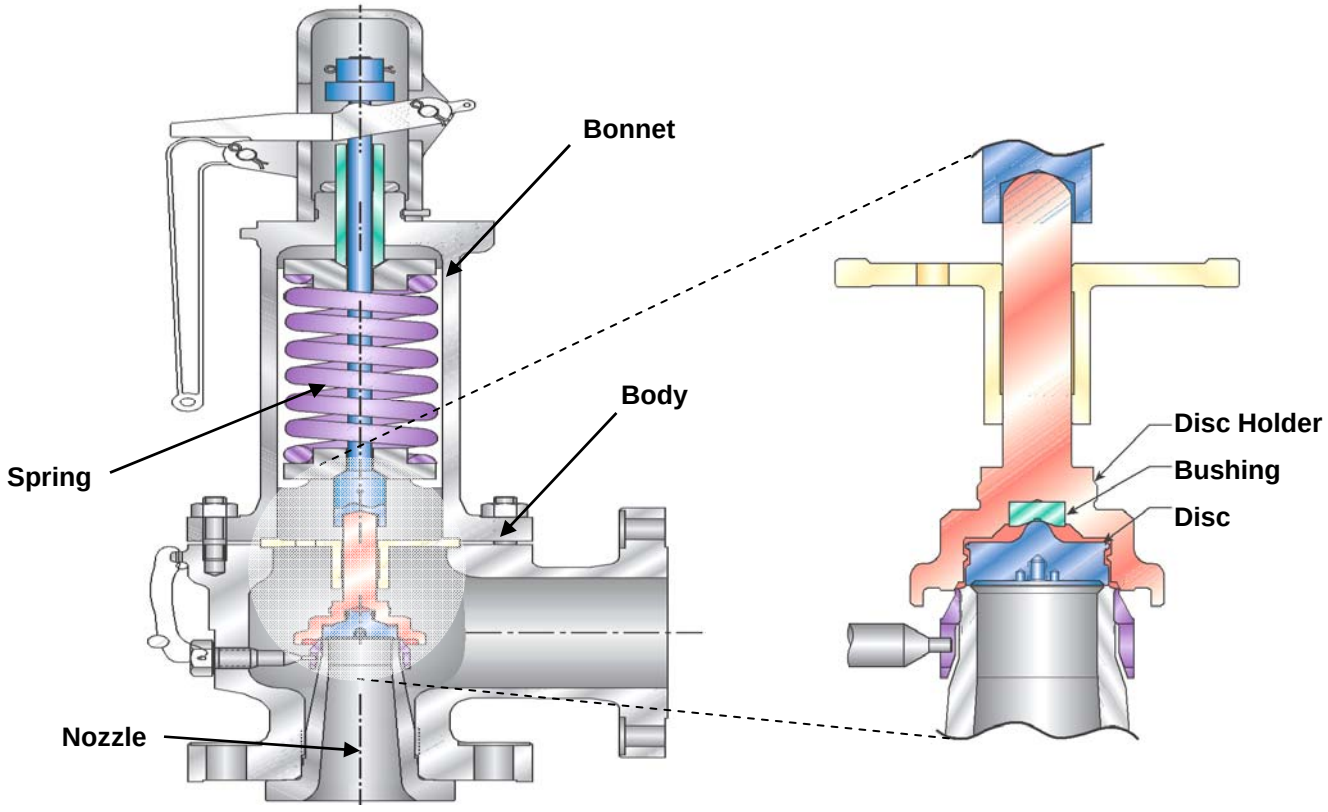


Figure 2.2
Seven 6" Diameter Pressure Relief Devices and Exhaust "Horns"
Valero Refinery

Thermal Relief Valves: Thermal relief valves protect liquid pipelines from over-pressurizing. Since the compressibility of liquid is minor, releases from thermal relief valves are normally small. These valves close as soon as the pressure in the closed system is relieved. These valves are generally vented to process drains, back into a pipeline, or into the atmosphere.

Rupture Disks: A rupture disk is a thin metal disk or diaphragm set between flanges often located on the pressure side of the relief valve or downstream from a block valve. Rupture disks are used to protect relief valves from the process pressure. They are designed to burst at the relief valve setting. Owing to their "one-time" use, rupture disks are applicable for relief devices where the component will be taken out of service after a release, for repairs or retrofits. Because they can only be used once, they are installed with block valves that will ensure that the piping can be closed once the emergency is contained. Rupture disks can also be used in place of relief valves in certain applications.

B. Emissions from PRDs

PRDs emit air pollutants when they "lift" to relieve pressure in the equipment they are serving. Such releases are often referred to as "episodic" releases because they occur only during process upsets when the PRD opens to relieve overpressures. In general, episodic emissions from PRDs can vary greatly, from a few pounds to many tons of material. Also, the duration of releases can vary greatly – from as little as seconds to as much as a day. Emissions may not correlate with the duration of venting because the components equipped with

PRDs process a range of materials and operate under a wide range of pressures.

PRDs can also release material through leaks. Emissions from leaks are often referred to as "fugitive" emissions, and are addressed in District Regulation 8, Rule 18: Equipment Leaks, which requires periodic leak inspections of all PRDs.

C. Detecting and Characterizing Emissions from PRDs

Facility operators rely on a variety of indicators to determine whether or not a PRD has vented and what kind of release was involved.

Telltale Indicators:

A telltale indicator, a physical device placed on the PRD's exhaust outlet in such a way that it will be moved or otherwise impacted if any material is vented out of the PRD, is one method of determining whether a PRD has experienced a release. Operators can readily determine whether there has been a release by simply looking at the device to see whether it has been activated. Some common telltale indicators are:

- Socks – Socks are pieces of cloth or other material placed over the exhaust of a PRD such that when the PRD releases, the sock is blown off by the releasing gas. If the sock is absent, that is a telltale sign that there has been a release.
- Flags – Flags are brightly colored metal tabs that are activated during a venting and become visible and can be easily seen by an operator.
- Rupture Disks – As mentioned above, rupture disks are thin metal diaphragms held between flanges. When the PRD releases, the disk will rupture. A ruptured disk is a telltale sign that there has been a release.

Telltale indicators are very useful in determining whether there has been a release. However, they do not provide any information about the release, such as when it occurred, how long it lasted, how much material was involved, or the nature of the material released.

Other Indicators:

In addition to a telltale indicator, there are other ways to determine whether a PRD has lifted. These include:

- Audible indicators – When PRDs vent, they normally make a loud distinctive sound.
- Pressure indicators – PRDs are pressure relieving devices that are set at a specific pressure. When a process has an overpressure that causes a PRD to lift, it normally leaves a characteristic "pressure signature" that indicates that a release occurred. This pressure signature is marked by rising pressure as the system approaches the PRD's set point, then a leveling off of the pressure as the PRD opens to vent the accumulated gases, and then falling pressure after the PRD closes and the process

returns to a more stable state. Monitoring the pressure within the system can thus provide a good indicator that a release has occurred. Pressure monitoring is most useful when there is a device that measures the actual pressure at the PRD. In many situations, however, the monitoring is in the vessel or equipment protected by the PRD, and the actual pressure experienced by the PRD must be calculated based on engineering calculations.

- Temperature – Temperature can be used as a way to indicate the release of a PRD. As temperature increases, pressure will also increase, triggering a release. A decrease in temperature indicates pressure relief.
- Flowrates – Process flowrate can also indicate the venting of a PRD. An initial increase in a process flowrate from a vessel indicates a pressure increase. A leveling off or decrease in the flowrate would indicate flow being released at another point, such as at a PRD. Although the process flowrate is a surrogate indicator, this information taken along with pressure readings can be used to indicate and quantify a release event.

None of these mechanisms, by itself, provides an ideal record of a release. For example, an audible indicator may be missed if there is nobody in the vicinity to hear it, or if the sound is masked by other noises at the facility. Indications from a pressure, temperature or flowrate monitor may be missed if the operator is not actively watching the monitor at the time of the release or if the monitor is not equipped with an alarm or notification system. Telltale indicators, as mentioned above, do not quantify the type or quantity of a release, and may indicate a release where none has occurred, such as when a sock is blown off in bad weather. Used in combination, however, these mechanisms can create a comprehensive monitoring system that will reliably detect and alert operators of any PRD releases.

Such monitoring systems can also reliably characterize PRD releases and provide the information that must be reported to the District under Rule 8-28 for any release over 10 pounds, such as the type and quantity of the emission.[ii] This information can normally be obtained by reviewing operating data from the equipment involved in the release. For example, a review of operating pressure may reveal a PRD release "pressure signature" described above: pressure increasing at a certain time, then leveling off at the PRD's set point, and then decreasing after a short time. By reviewing the type of material that the equipment was processing at the time, the pressure at which the PRD opened, the size of the PRD opening, the time period over which the PRD was open, and other factors, one can characterize the release fairly accurately.

Leak Detection:

PRDs can easily be inspected for leak-tightness with a portable analyzer that is placed near the PRD to detect any vapors that are leaking out. Using such

[ii] Current requirements of Rule 8-28 are discussed in Section III. B. 2.

equipment, facility staff and District inspectors can determine if any PRDs are leaking, and if so to what extent. Facilities are required by Rule 8-18 to inspect all PRDs regularly, and District inspectors conduct their own inspections to verify compliance.

D. PRDs Currently In Service In The Bay Area

There are 324 atmospheric PRDs located at the five Bay Area refineries. Of the 324 PRDs, approximately 50 are either rupture disks or pressure relief valve / rupture disk combinations, with the remaining being pressure relief valves. Approximately ten of the PRDs are equipped with socks as telltale indicators and the vast majority have some type of pressure monitoring, although some monitoring devices are remotely located and do not directly measure the pressure experienced at the PRD. Table 2.1 summarizes the total number of atmospheric PRDs located at each refinery.

Table 2.1
Population of Atmospheric PRDs at Each Refinery

Refinery	Atmospheric PRDs
Chevron-Texaco	41
ConocoPhillips	12
Shell	107
Tesoro	99
Valero	65
Total	**324**

Chemical Plants in the Bay Area also use PRDs on various process units. These PRDs usually service components containing non-hydrocarbon compounds, and have experienced only five reportable releases (over 10 pounds) since the 1997 amendments to Rule 8-28, involving only 2 tons of material in total. Further Study Measure 8 and the current rule development effort are focused on hydrocarbon emissions from PRDs at refineries.

III. REGULATORY HISTORY

Control of emissions from PRDs has been a focus of the District's regulatory attention for over 25 years. This section provides an overview of how Regulation 8-28 has evolved over the years into its current form, in order to provide some context for the proposed amendments.

A. 1980 – Adoption of a PRD Leak Standard

Rule 8-28 was originally adopted July 16, 1980, and regulated fugitive emissions (leaks). The rule established a leak standard of 10,000 parts per million for PRDs, but it did not place any restrictions on PRD venting as long as the venting was reported and the PRD reseated (closed) after releasing any excess

pressure. The rule also required quarterly leak inspections for accessible PRDs and annual inspections for inaccessible PRDs. Since adoption in 1980, minor amendments were made to the rule in 1981, 1982, 1983, and 1994.

B. 1997 – Addition of Prevention Measures and Targeted PRD Control Requirements

In the 1990s, the District undertook a comprehensive review and overhaul of Rule 8-28, which changed the focus of the rule from fugitive emissions from leaks to episodic emissions from PRDs venting to prevent equipment over-pressurization. District staff spent a considerable amount of time over a number of years on this effort, and the District's Board of Directors convened an ad-hoc committee to look into PRD-related issues and provide direction at the Board level. That process, and the amendments that resulted from it in 1997, are outlined below.

1. The Rulemaking Process

1991 Clean Air Plan Control Measure C1:

The District's efforts to overhaul Rule 8-28 began with Control Measure C1 in the 1991 Clean Air Plan. Measure C1 directed staff to examine Rule 8-28 further in order to determine whether there were any additional opportunities to reduce emissions of ozone precursors (effectively, hydrocarbons). Upon adoption of the 1991 Clean Air Plan, staff began to work on the issue.

Concern Over Acutely Hazardous Materials Releases:

As this process was underway, concern arose over the potential for releases of "Acutely Hazardous Materials" – highly toxic substances such as chlorine and ammonia, and flammable gases that could ignite and cause an explosion – as a result of recent industrial accidents. This concern led the Board of Directors to establish an Ad Hoc Committee on Accidental Emissions ("Ad Hoc Committee").[iii] The charge of the Ad Hoc Committee was to assess the need for any additional District regulation, above and beyond existing laws and regulations addressing environmental impacts from industrial accidents. The charge of the Ad Hoc Committee was set forth in the following "Policy on the Accidental Release of Acutely Hazardous Materials," which was approved by the full Board of Directors on February 16, 1994:

> The District Board will consider adoption of procedures or regulations designed to minimize the possibility of public exposure to accidental releases of Acutely Hazardous Materials by supplementing or supporting, not duplicating, current federal, state and local regulations designed to prevent or minimize such releases.

[iii] Of the current membership of the Board of Directors, Director Harold C. Brown Jr. served on the Ad Hoc Committee.

The creation of the Ad Hoc Committee, and its mission of addressing the potential for industrial accidents, led staff to expand the focus of their ongoing efforts to implement Control Measure C1 from the 1991 Clean Air Plan. District staff, along with members of the public, industry representatives, and other interested persons, participated in a number of Ad Hoc Committee meetings from 1993 through 1996. The Committee looked in great detail at all types of emissions from PRDs, including acutely hazardous materials as well as other materials that may not be considered acutely hazardous but are still of concern from an ambient air quality perspective (*e.g.*, ozone precursors).

The Committee examined existing legal framework covering environmental and public health impacts from industrial accidents. In addition to presentations from District staff, the Committee heard testimony from a large number of agencies with jurisdiction over these issues, including:

- The United States Environmental Protection Agency;
- The California Environmental Protection Agency;
- The Contra Costa County Health Services Department, and in particular the Department's Hazardous Materials Division;
- The San Francisco Bay Regional Water Quality Control Board;
- The California Occupational Safety and Health Administration;
- The United States Coast Guard;
- The California State Lands Commission;
- The California Public Utilities Commission;
- The Contra Costa County Fire Protection Department;
- The Richmond Fire Department; and
- The California State Fire Marshal Association.

These investigations highlighted the comprehensive nature of existing laws and regulations addressing industrial safety and the prevention of accidental releases of acutely hazardous materials. The centerpiece of these legal requirements is Section 112(r) of the federal Clean Air Act (42 U.S.C. § 7412(r)), which requires that owners and operators of industrial facilities handling acutely hazardous materials "design and maintain a safe facility taking such steps as are necessary to prevent releases. . . ." This Clean Air Act requirement complements the requirement in Section 5(a) of the federal Occupational Safety and Health Act (29 U.S.C. § 654(a)) that employers ensure that their workplaces are "free from recognized hazards that are causing or are likely to cause death or serious physical harm" to employees. The Clean Air Act requirement broadens the Occupational Safety and Health Act requirement and forces facilities to address risks to off-site communities in addition to risks to employees of the facility. These authorities establish the basic legal requirements that each facility must take whatever steps necessary to render their operations safe to workers and to neighboring communities.

Clean Air Act Section 112(r) also established a mechanism to ensure that facilities are taking the steps necessary to make their operations safe. Section 112(r) requires that any facility handling acutely hazardous materials above certain threshold quantities must develop a risk management program that includes: (i) an assessment of all hazards associated with a facility's operations, including absolute "worst-case" accidental releases; (ii) an integrated prevention program containing procedures to prevent accidents from occurring; (iii) an emergency response plan setting forth procedures to respond to accidents; and (iv) preparation of a Risk Management Plan ("RMP") document summarizing the program, which must be submitted to the agency with oversight for facility safety (which in the Bay Area is the local city or county hazardous materials agency).

At the state level, the California Accidental Release Prevention ("CalARP") Program imposes similar requirements. The CalARP requirements, which are set forth in Health & Safety Code Sections 25531-25543.3, implement the federal program in California and are intended to further the twin goals of "reducing regulated substances accident risks and eliminating duplication of regulatory programs . . . ." (Health & Safety Code § 25531(e).) To that end, the CalARP Program requires the preparation of a Risk Management Prevention Program ("RMPP") that satisfies the federal RMP requirements as well as certain additional California-specific requirements. The Governor's Office of Emergency Services ("OES") administers the CalARP program and has adopted implementing regulations in Title 19, Division 2, Chapter 4.5 of the California Code of Regulations.

The RMPP process is implemented at the local level by cities and counties. These "administering agencies" (also known as "Certified Unified Program Agencies" or "CUPAs") are specifically directed to coordinate their efforts with the local air quality management district (Health & Safety Code § 25533(b)), and may authorize the local air district to conduct a technical review of a facility's RMP (Health & Safety Code § 25535(a)). In addition, many cities and counties have adopted ordinances imposing their own city- or county-specific requirements. One example the Ad Hoc Committee reviewed in detail was the Santa Clara County Toxic Gas Ordinance (Ordinance No. NS-517.44).

Finally, in addition to the legal framework outlined above, the Ad Hoc Committee also investigated the cooperative efforts of the various agencies with jurisdiction over acutely hazardous materials issues to coordinate their regulatory activities. One prime example was the Contra Costa County Hazardous Materials Interagency Task Force, or "HIT Team." The HIT Team (which continues to operate today) is a coalition of agencies with responsibility for public and environmental health and safety that have joined in a cooperative and voluntary effort to enhance their level of service. The agencies represent federal, state, regional and local governments in the San Francisco Bay Area; local agencies are from Contra Costa County. The Task Force provides members with a continuing forum to coordinate and improve efforts in accident prevention;

emergency response; communication, outreach, and public participation; and efficiency, including the identification of both gaps and overlaps in policies and programs to protect the public's health and safety. District staff participates in the HIT Team and adds their expertise and support to furthering the Team's mission.

Given the level of existing regulation regarding accidental releases of acutely hazardous materials, and mindful of the Committee's charge that the Board did not want to duplicate existing federal, state, and local regulatory efforts unnecessarily, Staff ultimately concluded that no additional District regulation in the are was needed. Staff concluded that additional regulation would be duplicative and would disrupt the existing regulatory system, and that the District's efforts would be better spent in participating with the other agencies to share District staff's knowledge, information, and expertise.[(3)] Based on these conclusions, the Ad Hoc Committee did not recommend any additional District regulation aimed at preventing industrial accidents, over and above what was already being done by other agencies.

The Ad Hoc Committee process did reaffirm the need for additional regulation on PRD releases to address air quality issues from emissions that are not acutely hazardous. For example, situations where hydrocarbons are emitted at petroleum refineries from the top of a tall stack, where they are not near an ignition source and will dissipate into the atmosphere, do not present acute health hazards to employees and neighbors of the refinery. Such emissions can still be very important from an ambient air quality perspective, however, because they contribute to ozone formation. Hydrocarbons, along with oxides of nitrogen ("NOx"), are the main focus of the District's efforts to control ozone. The Ad Hoc Committee therefore recommended moving forward with efforts to address episodic emissions of hydrocarbons from PRDs, as contemplated by Control Measure C1 from the 1991 Clean Air Plan.

Regulatory Approaches Considered:

Based on this direction from the Ad Hoc Committee, staff then went forward with its rulemaking efforts along those lines. Staff conducted meetings with the regulated community and interested members of the public, prepared a Rule Effectiveness Study and a Technical Assessment Document, and ultimately proposed the current Rule to Board of Directors in December of 1997. During this process staff considered three approaches to controlling episodic PRD emissions (in addition to the option of doing nothing). The approaches considered were the following:

- Prevention Measures Only, With No Controls:

  This approach would have required affected facilities to implement a Process Hazards Analysis to identify and analyze potentially hazardous scenarios. For each hazard identified, the facility would be required to implement at least three "Prevention Measures" designed to minimize the

potential for releases. This approach would not have required any PRDs to be vented to control equipment.

- Blanket Control Requirement:

  This approach would have required all PRDs to be vented to a control system, such as a flare or a vapor recovery system. Affected facilities would have to pipe all of their existing PRDs to a control system, so that if any of them experienced a release, the emissions would either be captured or returned to the refinery's process or be incinerated before they reached the atmosphere.

- Targeted Control Requirement:

  This approach was essentially a hybrid of the prevention measures approach and the blanket control approach. It embodied the goal of eventually eliminating all PRD emissions to the atmosphere, but did not require all existing PRDs to be controlled immediately. Instead, it was designed to phase out atmospheric PRDs over time as the equipment they serve is replaced. It required facilities to vent PRDs on all new equipment to control systems, and to vent PRDs on existing equipment to control systems when the equipment is "modified" – that is, expanded or upgraded. In addition, this approach attempted to target the "bad actors" among the existing PRD population – those in service on potentially unstable processes that have a higher potential for an upset that might lead to over-pressurization and result in a PRD release. The approach required any process unit that experienced a PRD release twice within a five year period to be controlled within a year, without waiting for upgrade or overhaul. These targeted control requirements were in addition to the prevention measures outlined above, which would be required for all PRDs.

Staff evaluated the cost of each of these approaches and the emissions reductions each one could be expected to achieve. Staff found that the blanket control approach would be the most effective at reducing emissions, because it would essentially eliminate all PRD releases to the atmosphere. But staff found that it would be prohibitively expensive given the extensive capital improvements that would be necessary in relation to the amounts of emissions reductions involved. Staff calculated that requiring controls would likely require each affected facility to construct a new flare system, at a total annualized cost of approximately $27 million, or approximately $40,000 per ton of emissions reductions.

By contrast, staff found that the targeted control approach would be far more cost-effective, because it would not require expensive control systems for the bulk of PRDs that have low hydrocarbon emissions potential. Yet it still would obtain significant emissions reduction benefits because it would control the problem PRDs that are the worst contributors of smog-forming emissions, and

would minimize the likelihood of releases from all PRDs. Staff found that this approach could obtain emissions reductions at around half the cost-per-ton of the blanket control approach, and potentially as little as $3,450 per ton. Staff therefore identified the targeted control approach as the preferred alternative, and proposed amendments to the Board of Directors to codify that approach. The Board adopted the amendments on December 9, 1997, and made minor technical amendments in March of 1998.

2. Current Requirements of Regulation 8, Rule 28

The current version of Regulation 8, Rule 28 that the Board adopted in 1997 (with minor subsequent amendments) implements this targeted control approach in the following manner.

New Sources

When a facility installs a new source, Rule 8-28 requires that any PRDs on the equipment must meet District Best Available Control Technology (BACT) requirements, as defined in Regulation 2, Rule 2 and the District BACT Guidelines. BACT requires PRDs to be vented to a fuel gas recovery system, furnace, or flare with a control efficiency of at least 98 percent. This means that no new PRD may vent directly to the atmosphere.

Existing Sources

For existing sources with atmospheric PRDs, Rule 8-28 requires that the facility meet the BACT requirements – *i.e.*, venting all PRDs on the source to a control system – when the equipment undergoes a major modification. This provision means existing atmospheric PRDs will eventually be phased out as existing equipment is upgraded. There is no set timetable for equipment upgrades, and some equipment may remain in service for a long time before it undergoes a "major modification", but ultimately when equipment is upgraded, any atmospheric PRDs will have to be vented to a control system.

The rule also requires existing sources with atmospheric PRDs to implement Prevention Measures designed to prevent or minimize any releases. These Prevention Measures include: enhancing training, equipment, inspection, maintenance and monitoring procedures; installing process flow, temperature, level, and pressure indicators with interlocks; implementing documented and verified routine inspection and maintenance programs; using inherently safer designs; and installing deluge systems to cool and condense emissions before they can reach the atmosphere.

Finally, for existing sources, the rule also targets process units that show a propensity for releases. If a source experiences a release from a PRD over 10 pounds, it must: (1) conduct a failure analysis to discovery the cause of the release; (2) review the prevention measures for the source and address any

deficiencies; (3) evaluate whether it would be technologically feasible and cost-effective to vent the PRDs on the source to a control system; and (4) install telltale indicators on all of the PRDs on that source to ensure that any further releases are detected. If the same source experiences a second release within 5 years, that source must have all of its PRDs vented to a control system within one year. In this manner, the rule requires facilities to target their efforts to control existing PRDs towards sources that demonstrate a propensity for upsets and releases.

Reporting Requirements for Refineries and Chemical Plants

All Release Events (PRD releases over 10 pounds) at petroleum refineries or chemical plants must be reported to the District by the next working day. PRDs must be inspected within five days of a Release Event to ensure that they have re-seated properly and are not leaking. Within 30 days, the facility must report:

- the date, time, and duration of the Release Event;
- the device that experienced the Release Event;
- the District-assigned episode number;
- the type and size of device;
- the type and amount of material released;
- any information used to estimate duration and amount released;
- the cause of the release;
- the schedule for implementation of measures to prevent re-occurrence; and
- the results of the fugitive emission inspection.

The requirement to report this information implies that facilities must monitor PRDs to determine whether a Release Event has occurred and if so, the duration, cause, type and amount of material released must be quantified. There are currently, however, no explicit monitoring requirements in the rule.

C. Other District Regulations Applicable to PRDs

There are three other District regulations that are directly applicable to PRDs: Regulation 8, Rule 5 (Rule 8-5); Regulation 8, Rule 18 (Rule 8-18); and Regulation 8, Rule 22 (Rule 8-22).

Rule 8-5: Storage of Organic Liquids

Rule 8-5 requires the pressure vacuum valves (a type of PRD) on tanks used to store organic liquids be set at a pressure within 10 percent of the maximum working pressure of the tank and that the valves be properly installed and maintained in good working order.

Rule 8-18: Equipment Leaks

Rule 8-18 addresses fugitive emissions of VOCs from various components, including PRDs, at petroleum refineries, chemical plants, gasoline bulk terminals

and bulk plants. Fugitive emissions are those that escape from non-airtight fittings or connections. Rule 8-18 prohibits VOC leaks from PRDs over 500 ppm, subject to certain qualifications.

Rule 8-22: Valves and Flanges at Chemical Plants

Rule 8-22 addresses fugitive emissions of VOCs from small chemical plants. When fugitive emissions rules were amended in 1990, large chemical plants were made subject to the more stringent rules for petroleum refineries. Rule 8-22 was maintained for small (fewer than 100 valves) chemical plants.

IV. RULE EVALUATION

In the San Francisco Bay Area 2001 Ozone Attainment Plan for the One-hour National Ozone Standard, the District committed to study several activities at petroleum refineries to determine if additional reductions in emissions of ozone precursors could be achieved. One commitment, set forth in Further Study Measure 8, was to evaluate the potential for obtaining further ozone-precursor (*i.e.*, hydrocarbon) reductions at refineries by venting more refinery PRDs to control systems.

Staff has evaluated the effectiveness of the current rule and has concluded that overall, Rule 8-28 has been very effective and has resulted in a significant reduction in hydrocarbon emissions from PRDs. As noted above, the Rule is designed to phase out atmospheric PRDs by requiring them to be vented to control systems when new equipment is installed and when existing equipment is modified. For existing atmospheric PRDs that have not yet been phased out, the rule requires operators to implement Prevention Measures designed to prevent or minimize releases. The rule also targets "bad actors" out of the current population of existing atmospheric PRDs – *i.e.*, those demonstrating a high potential to have an upset that leads to a release – by requiring any source that experiences multiple releases to vent all of its PRDs to a control system within one year. In this way, the rule balances the desire to have state-of-the-art equipment in place on all equipment, with the reality that there are very many existing atmospheric PRDs and it would be highly burdensome to require them all to be upgraded immediately.

The merits of this targeted approach in reducing emissions are clearly evident when PRD emissions before prevention measures were required are compared to emissions after the prevention measures were required. The average annual emissions before the requirement became effective were 32.4 tons; average annual emissions after the implementation of the prevention measures is 8.6 tons.[iv] This difference represents an overall reduction in annual average emissions of 73 percent. Further, the average amount of emissions per release

[iv] Annual average emissions values are PRD population weighted. Since July 1, 1998, there have been 31.0 PRD-months before the prevention measures were implemented and 57.9 PRD-months after the prevention measures were implemented.

was 2.9 tons before the prevention measures were required; after the prevention measures requirement went into effect, the average was 1.3 tons (a 55 percent reduction in emissions per release). Before the prevention measures, there were six release events with emissions of five tons or more; since were required, there have been only two. (A full emission-reduction analysis is provided in Section VI.)

These successes notwithstanding, staff has concluded that there are several areas where the rule can be improved. Staff has reached this conclusion after several years of rule evaluation efforts. Beginning at the end of 2001 and continuing through mid-2002, District staff conducted an audit of PRDs located at the five Bay Area refineries. Staff reviewed data made available by the refineries that would indicate PRD venting, such as pressure, temperature, and flow data. The goals of the audit included (1) identifying all PRDs that vent directly to the atmosphere at units common to all refineries (*e.g.*, hydrotreaters and hydrocrackers), (2) verifying the PRD set points, and (3) determining to what degree of confidence the District can establish whether the PRDs at the refineries experienced releases during the audit period.

The 2002 Audit concluded that for many PRDs, the refineries do not have a means of adequately monitoring PRD releases. In some cases, the facilities do not have equipment capable of monitoring parameters that would indicate a release has occurred. Often, operators simply rely on sound to detect releases. In other cases, the facilities may have monitoring equipment, but it does not present an accurate picture of whether the PRD released, for example because pressure monitors are remote from the PRD and do not reflect actual pressure conditions at the PRD itself. In still others, the facilities may have monitoring equipment, but it records data in one-minute averages, which may miss short ventings. The Audit further concluded that the refineries do not routinely record data on operating parameters that could be used to indicate releases, and where they do record such data, in some cases they do not retain it for any length of time. The audit also discovered two small PRD releases during the audit period that had not been detected by refinery staff. These were both below the 10 pound reporting threshold and so did not trigger any requirements of the rule. But the existence of undetected small releases raises a concern that the refineries may have failed to detect some larger releases as well.

After completion of the PRD Audit, staff then proceeded to draft a Technical Assessment Document, which was published in December, 2002. The draft Technical Assessment Document reiterated the findings of the PRD Audit report and recommended several actions to improve Rule 8-28, including the addition of an explicit monitoring requirement to ensure that all PRD ventings are detected and addressed.

Based on these investigations and subsequent rule evaluation work, Staff has identified the following areas where Rule 8-28 could be improved.

A. Areas for Improvement of Current Rule

Detecting and Characterizing Releases

Section 8-28-401 of Rule 28 requires that facilities report all releases of over 10 pounds of any air pollutant from a PRD. Facilities must provide detailed information about each release, such as the duration of the release and the type and amount of material released, along with the data and assumptions used in calculating this information. However, there is no explicit requirement that facilities have equipment installed to enable them to detect all such releases and collect the information that must be reported, and there is no standard by which to determine compliance. As a result, facilities are using a variety of different monitoring approaches for their various processes and equipment, which vary greatly in their ability to detect and quantify releases. For example, the vast majority of PRDs have some sort of pressure monitoring of the system being served by the PRD, but few of them actually measure the pressure at the PRD itself. Some monitoring systems are not sensitive enough to detect small releases, and may not be detecting releases near the 10 pound threshold that triggers the reporting requirement. For these reasons, staff believes that facilities need to ensure that they have the capability to detect, characterize, and record all PRD releases, and that they need to demonstrate this capability to the District.

Data Recording and Retention

In cases where facilities do currently have monitoring equipment in place that can detect PRD releases, monitoring data are often not recorded or retained. The lack of data retention for some PRDs makes it difficult for District Enforcement staff to independently verify the pressure and venting history of those devices. Enforcement would be enhanced if measurements and recordings of the pressures experienced by the PRD were maintained for an explicit period of time in the rule. The time period should be long enough to allow a facility and/or District staff to go back and review the details of an incident some time after the fact, in situations where it was not immediately obvious that there were issues of interest to be investigated.

Definition of Equipment Subject to the Rule

Several provisions of Rule 8-28 use the term “source.” These include the provision that requires the installation a telltale indicator on each PRD on a refinery “source” within 120 days following a release event from that source (§ 8-28-304.1); and the provision that requires each PRD on a “source” to be piped to an emissions control device following a second release within five years from any PRD on the “source” (§ 8-28-304.2).

However, the term “source” as it is used in the rule can be interpreted in various ways, which can lead to confusion on how the rule is to be implemented. Typically, petroleum refineries have a vast array of interconnected pieces of process equipment and a large number of pumps, compressors, and piping to

move petroleum products between the various stages of refining. Because these equipment typically do not operate in isolation, various equipment and groups of equipment have been defined as "sources" over time for different regulatory purposes. For example, in one context "source" may be used to refer to an individual piece of equipment, such as a pressure vessel. In other contexts, "source" may be used to refer to an entire process unit, which may be made up of a large number of pressure vessels, piping, and related equipment. The rule does not explicitly indicate which definition should be used in the context of Regulation 8-28, and the general definitions in other regulatory provisions (*e.g.*, Regulation 1, Rule 1) are not specific enough to provide further guidance.

The lack of a clear definition of "source" can lead to confusion in how the rule is applied, given that all PRDs on a "source" need to be fitted with a telltale indicator after a first release event and must be piped to an emissions control device if there is a second release event within five years. If "source" is defined narrowly, for example as an individual pressure vessel, these requirements are triggered only for the PRDs on that particular vessel. If "source" is interpreted broadly, for example as an entire process unit comprised of multiple interconnected vessels, then these requirements will be triggered for all of the PRDs anywhere on that process unit, which would likely be a larger number.[v]

Staff has reviewed the history of the 1997 rule amendments that included these requirements and has determined that the intent of District staff in proposing the amendments, and the intent of the Board in adopting those amendments, was that "source" was to be defined broadly to encompass an entire process unit.[4, 5] The rationale for this definition is that Section 304 is targeted towards the "bad actors" – sources that are identified problems because they have demonstrated a propensity for repeat releases – and it is most appropriate to look to the entire process unit to determine which are the "bad actors." This is true for several reasons. First, a problem that causes a process upset resulting in an overpressure and PRD release will not necessarily be limited to a single pressure vessel. A fire in a process unit, for example, could lead to an upset in any pressure system anywhere on the unit. Second, even problems that arise a single pressure system could subsequently spread to other pressure systems within the process unit, for example as increased process rates in one part of the unit feed higher volumes of material than normal, or material at a higher temperature than normal, into downstream equipment causing a further upset there. Third, many of the Prevention Measures that must be implemented to prevent or minimize releases are implemented on a process-unit basis. If for whatever reason those Prevention Measures are not working as effectively as

[v] A "process unit" is generally understood to be a discrete component of the refining process that may contain one or more vessels and other pieces of equipment. Generally, it is physically distinct from other process units and can be isolated from the others process units and shut down if necessary. The equipment making up a process unit is normally closely grouped together physically and controlled from a common control room. The entire process unit is normally shut down as a unit for maintenance turnarounds. District permitting staff often (but not always) assign Source Numbers to refinery sources on a process-unit basis.

they should, the entire process unit on which the Prevention Measures are implemented should be considered suspect. For all of these reasons, it makes the most sense to look at the entire process unit when assessing which sources are considered problematic as a result of a history of frequent releases. Staff continues to believe that this approach is the most appropriate and that "source" should be explicitly defined to encompass all of the PRDs on an entire process unit. Providing an explicit definition to make the meaning of the rule clear would simply be a clarification of the existing requirements, and would not impose any additional requirements.

Defining "source" for purposes of Rule 8-28 differently than elsewhere in District regulations could cause further confusion, however. The term would have different meanings depending on the context in which it is used. A different term should be substituted for "source" in Rule 8-28 to avoid any potential for confusion. "Process unit" would be appropriate, as it describes the concept involved.

Definition of "Telltale Indicator"

The rule as currently written requires affected facilities to install "telltale indicators" whenever a source experiences a PRD release. Although facilities may have a general concept of what a telltale indicator is, it is not clear that there is a specific definition that is commonly accepted among those affected by this Rule. To ensure that there is a clear understanding of what a telltale indicator is and how to comply with the associated provisions, this term should be explicitly defined.

Reporting of Failure Analyses

Section 8-28-304.1 of the Rule requires affected facilities to undertake a failure analysis after experiencing a release event. This failure analysis must include an additional Process Hazards Analysis in which the facility must review its Prevention Measures for the equipment involved, as well as an analysis of the feasibility and cost-effectiveness of venting the PRDs on the source to a control system. The current rule requires that this failure analysis be completed, but it does not require that the analysis be submitted to the District or be retained for any period of time. Facilities should be required to submit the information to the District, or should be required to retain it and make it available on request, to allow District inspectors to readily verify compliance with this requirement.

Non-Substantive Amendments and Clarifications

Finally, the District's review identified several areas where the current language of the rule has become obsolete or is confusing in some way. These are not areas where the substantive requirements of the rule need to be changed. All that is needed are minor, non-substantive changes to make the rule more clear and workable.

B. Potential For Additional Control of PRD Emissions

The District has long believed that ideally, all atmospheric PRDs should be re-plumbed to control systems, which is the Best Available Control Technology.[vi] This belief was the basis of the targeted control approach that was adopted in 1997, which is intended eventually to phase out all atmospheric PRDs. The District did not require all existing atmospheric PRDs to be controlled immediately only because the large costs involved meant that it would not have been cost-effective compared to the emissions reductions that could be achieved. Instead, the District adopted the current targeted approach, which focuses on the few problem PRDs with a high potential to contribute to ozone formation without requiring control on the bulk of the PRD population that is not a significant ozone concern.

In Further Study Measure 8, the District committed to reevaluating its 1997 determination and examining whether additional reductions in refinery hydrocarbon emissions could be achieved by requiring additional refinery PRDs to be controlled. To do so, staff evaluated the emissions reductions that could be achieved from additional control requirements, as well as the costs that would be associated with such requirements. Staff has determined that requiring affected facilities to install control systems with capacity to handle all 324 existing atmospheric PRDs would likely cost between $1 million and $3.2 million per ton of emissions reductions achieved. These costs are roughly two orders of magnitude greater (*i.e.*, 100 times greater) than what the District normally considers to be cost-effective. Staff has therefore concluded that a blanket rule requiring all PRDs to be controlled would not be a cost-effective means to achieve Further Study Measure 8's goal of reducing emissions of ozone precursors from petroleum refineries. From the perspective of achieving additional reductions in ozone precursors, it would be preferable to maintain the current targeted approach and seek further reductions in other areas where the same level of benefit could be achieved at far less cost. (Full details of Staff's analyses of emissions reductions and associated costs are set forth in detail below in Sections VI and VII.)

Beyond reductions in ozone-precursor emissions, staff also considered the potential benefits of a blanket control rule in preventing or minimizing catastrophic industrial accidents. These issues are beyond the mandate of Further Study Measure 8, which is an ozone control measure from the 2001 Ozone Attainment Plan, an ozone planning document. Staff nevertheless examined catastrophic accidental release issues because of the importance of community and worker safety, and because there was significant public interest in these issues voiced during the rule development process. PRDs are safety devices designed to vent material in a pressure vessel quickly in order to prevent the vessel itself from rupturing or exploding. But by venting the material to

[vi] "Best Available Control Technology," or BACT, is a regulatory term used to refer to the current state of the art in emissions control technology.

relieve the pressure, PRDs can be implicated as the pathway through which acutely hazardous materials inside the vessel can reach the atmosphere. Piping PRDs to a control system could thus potentially help prevent or minimize certain types of impacts from industrial accidents. Staff, therefore, examined whether amendments to Rule 8-28 could help enhance facility safety.

Staff reviewed the existing regulatory environment covering facility safety and the prevention of hazards from accidental releases of acutely hazardous materials. Staff have reached the same conclusion that the Board's Ad Hoc Committee on Accidental Releases reached in connection with the 1997 Amendments: The current system of federal, state, and local laws and regulations provides a robust and comprehensive regulatory safety net designed to ensure that regulated entities "design and maintain a safe facility taking such steps as are necessary to prevent releases," in the words of Clean Air Act section 112(r). Staff found that the system has even been enhanced by further developments beyond what existed in 1997. Notably, Contra Costa County, the home of four of the five Bay Area refineries and multiple chemical plants, adopted a landmark Industrial Safety Ordinance in December of 1998 (with subsequent amendments in 2000).[vii] (*See* Contra Costa County Code, Title 4, Chapter 450-8.) The Industrial Safety Ordinance requires all affected facilities to develop a Safety Program to prevent releases, using inherently safer systems wherever feasible. The Ordinance requires each facility to document its Safety Program in a Safety Plan, which is then reviewed by the County and circulated to the public for comment. If the facility's compliance is determined to be deficient in any way – including with respect to the requirement to use all feasible inherently safer systems – the County can require the facility to revise its Safety Program to comply. In this way the Industrial Safety Ordinance provides yet another mechanism to ensure that facilities conduct their operations in a safe manner. Staff believes that these comprehensive and overlapping mechanisms, taken as a whole, provide a sound framework for preventing accidental releases of acutely hazardous materials, through PRDs or via any other avenue.

Staff has therefore concluded that adding additional control requirements to Rule 8-28 as a process safety measure is not warranted. Adopting Rule 8-28 amendments as a safety requirement, as opposed to a smog-control requirement as was contemplated by Further Study Measure 8, would be duplicative of these comprehensive safety requirements that are already in place. Duplicative regulation would be unwise as a matter of policy, and it is prohibited by Section 40727(b)(5) of the Health & Safety Code, which requires that the Board of Directors make a finding of non-duplication of existing regulations before adopting or amending a District rule.

Furthermore, even if the District were regulating in a vacuum without these existing safety requirements, requiring all PRDs to be controlled as a safety

[vii] District Director Mark DeSaulnier sponsored the Industrial Safety Ordinance in his capacity as Contra Costa County Supervisor for District IV.

measure would not be an advisable regulatory approach. A blanket District rule requiring control of all PRDs would be a crude instrument that would both over-regulate and under-regulate the problem. Such an approach would over-regulate the problem because it would require facilities to control PRDs on all processes, even those that have a very low potential for releases, or that serve low-volatility or low-toxicity substances that present very little acute risk to workers and neighbors should a release occur. There would be little to gain by controlling such low-risk PRDs, and the costs involved would essentially be wasted. By the same token, such an approach would under-regulate the problem because it would address only the potential for harm from air contaminants that are emitted from the operation through PRDs. It would not address safety risks from other categories of accidental releases, such as toxic liquids that could impact surface- or ground-waters. Similarly, it would not address the possibility of accidental air emissions from mechanisms other than PRD lifts, such as ruptures in pipes or other equipment that would allow emissions directly into the atmosphere regardless of whether PRDs were vented to control systems. Staff therefore believes that a blanket requirement that all existing atmospheric PRDs must be controlled would not be the most effective approach to addressing accidental release issues.

For all of these reasons, staff is not proposing that the Board of Directors adopt a blanket requirement that all existing atmospheric PRDs be vented to control systems.

V. PROPOSED AMENDMENTS

The rule review described above illuminated several areas in which the rule could be made more effective. Staff is therefore proposing that the Board of Directors adopt certain amendments to the current rule. The proposed amendments would:

- Explicitly require a monitoring system for all atmospheric PRDs. Section 8-28-503 in the proposed amendments establishes an explicit monitoring requirement. The requirement specifies that any monitoring system shall be designed, installed, operated and maintained so that operators are notified of releases as defined in the rule, and that the system can quantify them. This requirement is proposed to become effective June 1, 2007.
- Require facilities to demonstrate that they have adequate monitoring systems in place for all of their atmospheric PRDs subject to the rule. Section 8-28-407 is proposed to require facilities to submit a monitoring demonstration report that will enable staff to enforce the monitoring requirements. The report will require descriptions of the monitoring equipment, operating parameters and engineering calculations used to quantify releases.
- Require data recording and recordkeeping for venting and emissions verification. Section 8-28-502 is proposed to require that records of

pressure relief devices, prevention measures, equipment served, inspections, and monitoring equipment are kept and made available for inspection. Some of these records were required to be kept under Section 8-28-403, which is proposed for deletion.

- Clearly define the equipment subject to Section 304 of the rule to ensure that the original intent of the rule – to regulate all PRDs on process units that demonstrate a propensity for releases – is preserved. A definition of "process unit" is proposed in Section 8-28-216 and the term replaces the term "source" in Section 8-28-304.
- Add a definition of "telltale indicator." Facilities are required to install telltale indicators after a first release event, but the term is not defined. Defining the term will prevent any confusion over exactly what is required under such circumstances. The definition is in Section 8-28-217.
- Require facilities to identify all process units equipped with atmospheric PRDs and provide an inventory of all PRDs serving them. In order for staff to clearly understand all of the equipment subject to the rule, proposed Section 8-28-408 would require facilities to submit a list of all process units equipped with PRDs, identify all the PRDs on each process unit, and state when the first turnaround occurred at each process unit after 1998. The latter information is necessary to determine when the requirements of Section 304 came into effect for each process unit.
- Make minor, non-substantive changes to the rule, such as, deleting obsolete references to "turnarounds"; moving requirements where appropriate; and clarifying various sections of the rule. Initial compliance dates (the first turnaround after July 1, 1998) have been deleted in the proposed amendments; and the requirement to conduct a Process Hazards Analysis, an administrative requirement, has been moved from Section 8-28-304 to proposed Section 8-28-406.

VI. EMISSIONS

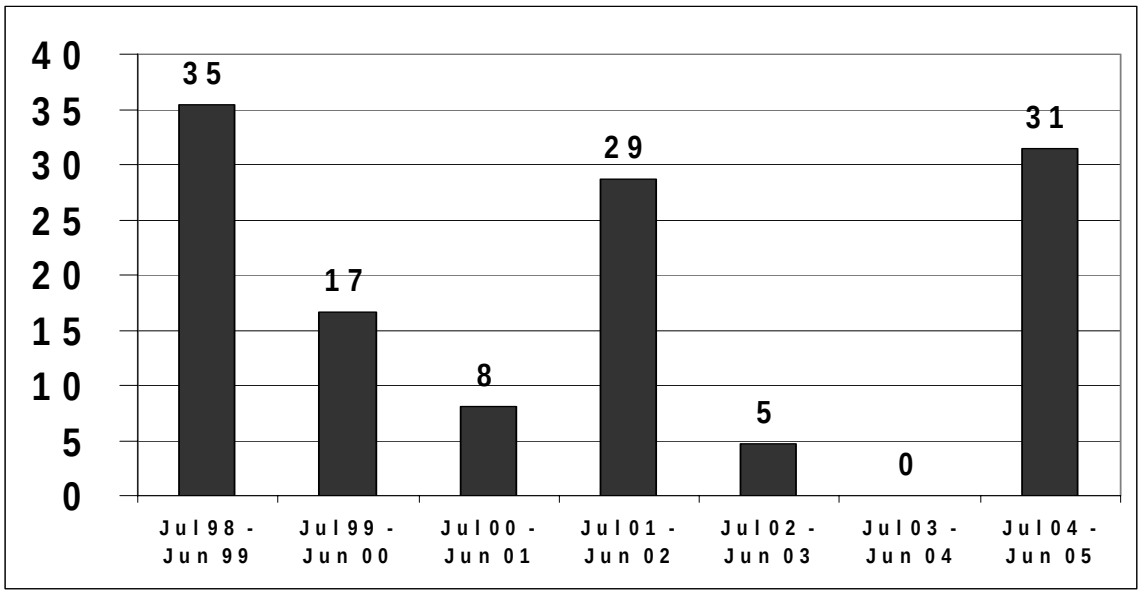
Episodic emissions from excess pressure in facilities' process units occur at the exhaust of the atmospheric PRD. These pressure releases result from problems in the process that could result in catastrophic failure of the process equipment if the pressure is not released in a controlled manner. Smaller amounts of emissions can also occur during normal pressure conditions if a PRD leaks.

A. Current Emissions Summary

1. Episodic Emissions

There have been 42 release events reported by the five Bay Area refineries since the current version of the Rule took effect in 1998 (through September 2005). These 42 release events vented an estimated 125 tons of VOC emissions in total. This record represents an average of 6 release events per year over this period, involving an average of 17.9 tons of emissions per year. The average release event involved 3.0 tons of emissions. Emissions during this period are summarized in Table 6.1 on a year-by-year basis.

Table 6.1
Summary of Annual Emissions from PRDs
Total tonnage, 1998-2005
(rounded to the nearest whole number)



In citing annual average emissions figures, it must be noted that although annual averages can provide a useful metric for assessing the scope of PRD releases within the Bay Area in general, they are of more limited value in assessing the amount of emissions to be expected from PRDs on any given day. PRDs normally go for long periods of time without ever opening, interspersed with short periods of significant emissions – sometimes as much as tens or hundreds of tons – when there is a process overpressure. This is the reason that the current rule requires controls on those PRDs with a high propensity for releases, even though control requirements are not cost-effective when looked at from an annual-average-emissions standpoint: A PRD that has one very large release per year will have low annual average emissions, but it should still be controlled to

prevent the significant ozone impact that would occur on the particular day that the release occurs.

It must also be noted that these emissions figures may be somewhat underestimated because of the potential that some releases may not have been discovered and reported to the District. As noted above, when staff audited refineries' current PRD practices they found that some PRDs do not have comprehensive monitoring systems and may have experienced some releases that were never detected. The refineries are confident that they have detected most (if not all) of the releases that have occurred, however. If any releases did go undetected, it is most likely that they were smaller events, as it would be hard not to detect a large release even without a comprehensive monitoring system. In addition, the emissions summaries do not account for emissions of less than 10 pounds because these small releases are not required to be reported to the District. But again, these are small events and the annual total of these emissions is not expected to be significant. Staff, therefore, believes that the data on current levels of PRD emissions are sufficiently reliable.

2. Fugitive Emissions

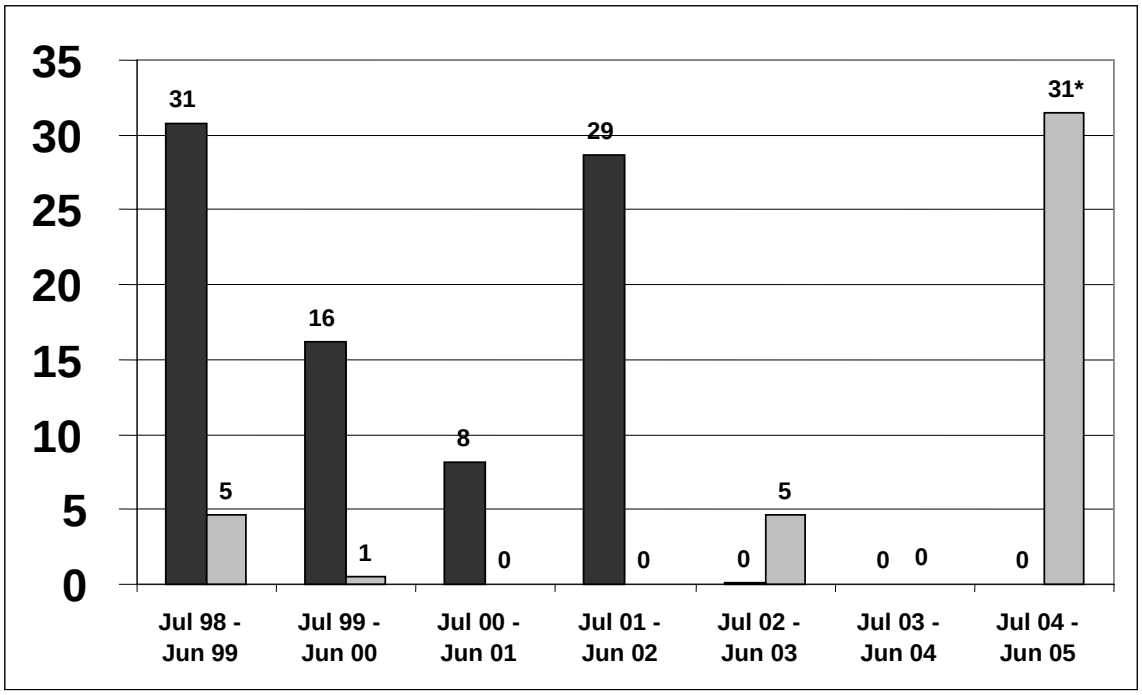
As noted above, the fugitive emissions requirements applicable to PRDs were moved to Rule 8-18 in connection with the 1997 rule amendments. Rule 8-18 currently establishes a very stringent 500 ppm leak standard, and requires periodic inspections to ensure PRDs are complying. Emissions from PRD leaks are currently estimated at approximately 10 pounds per day (as of 2003). This is a very substantial reduction from the 3300 pounds per day that staff estimated from leaks during the 1997 rule development process. The reduction can be attributed to several developments, including the tightening of the Rule 8-18 leak standard to 500 ppm and changes to the EPA method for calculating emissions from leaks. Staff believes that these reductions are further evidence of the success of the District's VOC emission rules, although in this case the success is attributable to Rule 8-18, not Rule 8-28.

B. Emission Reductions Since Adoption of the Current Rule in 1997

In assessing current emissions from PRDs, staff also examined the effect of the requirement that facilities implement Prevention Measures pursuant to Section 8-28-303 of the 1997 amendments. That section required each affected facility to take a number of steps to reduce the chance of PRD releases, such as operator training, improved equipment, inherently safer process designs, enhanced maintenance protocols, and monitoring systems. Affected facilities had to implement these Prevention Measures during the first "turnaround" (scheduled shutdown for routine maintenance) after the amendments took effect in 1998. To assess the effectiveness of this Prevention Measures requirement, staff compared emissions before the Prevention Measures requirement went into effect (*i.e.*, before the first post-1998 maintenance turnaround for each process

unit) and after the requirement was triggered (*i.e.*, after the first post-1998 turnaround).[viii] The results of this evaluation are presented in Table 6.2.

Figure 6.2
Comparison of PRD Release Event Emissions Before and After the Prevention Measures Requirement Took Effect
Total tonnage, 1998 – 2005
(rounded to the nearest whole number)



* The large emissions spike shown for 2004-2005 was primarily the result of two large releases at an alkylation unit at the Tesoro Refinery that vented 9.3 tons and 20.4 tons of hydrocarbons, respectively. Under Section 8-28-304.2, the PRDs on that unit will now be required to be vented to controls so that any further releases will not reach the atmosphere.

The results of this comparison show the effectiveness of the Prevention Measures requirement in reducing PRD emissions. Before the Prevention Measures requirement came into effect, emissions averaged 32.4 tons/year from these PRDs; after the Prevention Measures were required, the annual average

[viii] To make this comparison, staff looked at each process unit equipped with atmospheric PRDs and determined when the Prevention Measures requirement went into effect – the date of the process unit's first maintenance turnaround after July 1, 1998. Staff then compared the frequency and size of releases from that process unit before the Prevention Measures requirement took effect with the frequency and size of releases after the Prevention Measures requirement took effect. Staff then aggregated the data for all PRDs District-wide to obtain an overall comparison between emissions before and after the Prevention Measures requirement took effect.

has dropped to 8.6 tons per year. Furthermore, release events have become less common, and the release events that have occurred tended to be smaller. The average release event has fallen from 3.0 tons per release event before the Prevention Measures were required to 2.4 tons per release after the Prevention Measures were required. The number of significant releases has also declined. Before prevention measures were required, there were six release events greater than five tons; since the prevention measures requirement became effective, there have been only two. The distribution of release events by size is set forth in Table 6.3, and shows that the most common type of release before the Prevention Measures requirement came into effect was 1,000 to 10,000 pounds, whereas the most common type after the Prevention Measures requirement came into effect has been in the 10- to 100-pound range.

Table 6.3
Release Events Distributed by Amount of VOCs Released

Size of Release (pounds emitted)	Number of Releases Before Prevention Measures	Number of Releases After Prevention Measures
10 – 100	2	6
100 – 1000	7	1
1000 – 10,000	13	5
10,000 – 100,000	6	2

Staff believes that these demonstrated declines in the number of PRD releases, the amount of emissions per release, and overall PRD emissions, demonstrate the effectiveness of the Prevention Measures requirement in the current rule.

Staff also looked back even further and compared recent PRD emissions rates with historical emissions data prepared in connection with the 1997 Amendments. In the process of developing the Amendments, Staff documented 51 reported releases in the three years from 1993 through 1995 totaling an estimated 459 tons of emissions, which included a single very large event in 1993 that involved an estimated 371 tons. These figures represent an average of 17 release events per year during this period. On a mass basis, average emissions were 153 tons per year when the very large 459 ton release is included, or 27.2 tons per year if that single event is treated as an outlier and excluded from the calculation.(6) These historical emissions rates are significantly larger than the rates the region has experience since the 1997 amendments went into effect, both in terms of the number of releases per year and mass of emissions released per year. Release events dropped from an average of 17 per year in 1993-95 to an average of 6 per year since July of 1998. Total annual emissions dropped from an average of 27.2 tons per year or 153 tons per year in 1993-95 (depending on whether the very large 459 ton release is included) to an

average of 17.9 tons per year since July of 1998. These comparisons further highlight Rule 8-28's successful track record in reducing emissions.[ix]

C. Potential Further Emissions Reductions

Staff evaluated the emissions reductions that could be expected in two scenarios: (i) requiring a demonstration that every facility has comprehensive monitoring equipment in place for all PRDs in atmospheric service; and (ii) requiring all atmospheric PRDs to be vented to a control system with a destruction efficiency of 95 percent or greater. For each scenario, staff evaluated emissions reductions based on the 17.9 tons per year average emissions that the region has experienced overall since 1998, and also based on the smaller 8.6 tons per year average emissions that have occurred since the Prevention Measures requirement went into effect.

1. Reductions from Monitoring Demonstration

Establishing explicit standards for monitoring will allow the District to ensure that all facilities are adequately monitoring all atmospheric PRDs. Ensuring that such monitoring is in place will ensure that facilities are fully aware of release events, which will allow operators to better target their release prevention and mitigation efforts and will ensure that repeat-release "bad actors" are identified and subjected to additional control requirements. These effects, in turn, are expected to lead to fewer release events and reduced emissions.

US EPA has estimated from time to time in various rulemakings that enhanced monitoring can result in a ten to twenty percent emissions reduction. Here, staff believes that the proposal to add an explicit monitoring requirement should more appropriately use a five percent emissions reduction factor, because many PRDs are already subject to some form of monitoring and it appears that most releases – and especially the larger ones – are being detected.

Using the 17.9 tons-per-year average emissions figures from the period 1998-2005, a five percent reduction would result in emissions reductions of approximately 0.9 tons per year. Using the 8.6 tons-per-year average from the period after the Prevention Measures requirement came into effect, a five percent reduction would result in emissions reductions of 0.43 tons per year.

[ix] It must be recognized that other factors besides the adoption of the 1997 Amendments likely contributed to some of the observed emission reductions. For example, the Pacific Refining facility closed in 1997, taking a number of PRDs out of service and removing them as potential emissions sources. Any emissions reductions from independent influences such as this would have occurred even if the 1997 Amendments had never been adopted.

2. Reductions from Controlling Additional PRDs

Facilities can achieve a 98 percent reduction in emissions by venting releases to a control system such as a flare or recovery system. Using the 18.1 tons per year overall average annual emissions since 1998, a blanket control requirement could therefore be expected to result in emissions reductions of 17.5 tons per year. Using the 8.6 tons-per-year average since the Prevention Measures requirements came into effect, a blanket control requirement could be expected to result in emissions reductions of 8.4 tons per year.

VII. ECONOMIC IMPACTS

This section presents the economic impacts of the proposed amendments, and also addresses the economic feasibility of a blanket requirement that all atmospheric PRDs be controlled immediately.

A. Costs That Would Be Incurred by Affected Facilities

1. Demonstration Reports

The proposed rule amendments require that each affected refinery prepare and submit to the District a "Monitoring System Demonstration Report." This report would provide information that would demonstrate that the refineries have adequate monitoring systems in place for all of their atmospheric PRDs subject to the rule. Section 8-28-407 is proposed to require facilities to submit a monitoring demonstration report that will enable staff to enforce the monitoring requirements. The report will require descriptions of the monitoring equipment, operating parameters and engineering calculations used to detect and quantify releases. Staff estimates that preparing the needed information for inclusion in the report for each PRD would take about two man-hours per PRD. (Most of this information is already available and must be utilized in the event of a release event and the subsequent report to the District.) The hourly labor cost is estimated to be approximately $100 per hour. Because there are 324 PRDs in total at the five Bay Area refineries, staff estimates the total one time cost of this provision to be about $64,800.

The proposed amendments also require each affected refinery to provide a listing of each process unit equipped with atmospheric PRDs and the associated PRDs. This information is already generally available and would not require any additional man-hours to generate. Preparation of the report for submission should take no longer than one hour for each refinery. Staff, therefore, estimates the cost associated with this provision to be approximately $100 per refinery; this translates to $500 District-wide.

The total costs of the demonstration reporting requirements are therefore expected to be approximately $65,300.

2. Monitoring Equipment

The current rule implicitly requires that facilities monitor their PRDs so that they will know when they have a release that has to be reported in accordance with Section 8-28-401. A requirement to report release information implies a duty to investigate whether releases have occurred, which cannot be done without monitoring. The proposed amendments would simply make the monitoring requirement explicit. Simply making the requirement explicit should not involve any additional costs beyond what is currently required. Indeed, staff has found that most PRDs already have sufficient monitoring equipment to satisfy the requirements being proposed.

Staff recognizes that some facilities do not currently have comprehensive monitoring systems for all PRDs, however. Staff has therefore evaluated the costs of implementing monitoring systems, even though they are not technically additional costs imposed by the proposed amendments, and even though the many PRDs that already have comprehensive monitoring systems in place will not need to incur such costs.

Staff evaluated several types of equipment that could be used to implement a monitoring system that would satisfy the proposed monitoring requirements. Staff's evaluation was based on conversations with refinery personnel and cost quotes from vendors. The cost of installing of a telltale indicator, such as a sock, would range from $500 to $1000 per PRD. Costs for installation of pressure sensing devices to provide pressure monitoring capability would likely range between $1,000 and $1,500 per PRD.[7 8 9 10] Staff does not believe that any facility will be unduly burdened by such costs. Moreover, staff believes that any such costs would be more than justified in situations where facilities are not currently monitoring their PRDs.

3. Controlling Additional PRDs

Staff also examined what it would cost to expand the Rule to require all existing atmospheric PRDs to be retrofitted and vented to control systems. Staff examined costs under two scenarios:

(1) Refineries would have to install additional control systems to handle the PRD emissions (the more likely scenario); and

(2) Refineries would be able to use spare capacity in existing control systems to handle the additional PRD emissions, and would not have to install new equipment (a more conservative but far less likely scenario).

Staff has found that under either scenario, requiring all PRDs to be controlled would not be cost effective. Each scenario is described in more detail below.

Cost of Installing New Control Systems:

Most if not all affected facilities would be required to install a new control system (or multiple systems) if they were required to control all existing atmospheric PRDs. PRDs are designed to vent large amounts of material very quickly in order to protect equipment from overpressures. As a result, control systems handling PRD emissions (safety flares, predominantly) have to be designed to handle large amounts of material from each PRD. Moreover, to accommodate all foreseeable upset conditions that might trigger PRD releases, such systems need to be able to handle emissions from multiple PRDs simultaneously. As a result, requiring all PRDs to be controlled would require a very significant amount of control capacity. Staff does not believe that affected facilities have spare capacity in their existing systems to handle all of their atmospheric PRDs, and would thus have to install new flare systems instead. Staff has concluded that it would cost approximately $192.5 million District-wide to install new flare systems with a capacity great enough to handle all existing atmospheric PRDs.

Staff derived this $192.5 million estimate from two sources: (1) a cost study undertaken Jacobs Engineering, Inc. ("Jacobs Engineering"), a large refinery engineering and construction contractor, in connection with the 1997 Amendments; and (2) a recent cost estimate performed by the Shell refinery in Martinez pursuant to District Regulation 8-28-304.1.

Jacobs Engineering Estimate:

Jacobs Engineering concluded that it would cost approximately $20 million to install a new flare system capable of handling 50 PRDs.[11] This estimate was based on an accuracy range of +/- 30%, which translates to a cost range of approximately $14 million to $26 million. A summary of the Jacobs Engineering estimate is set forth in Table 7.1, broken out by line-item.

Table 7.1
Jacobs Engineering Cost Estimate for a Safety Flare Recovery System to Handle 50 PRDs

Component Descriptions	Cost Estimates
50 PRDs and relief lines, ¾" to 8"	$1,180,000
Relief Headers and Knockout Drum	$2,970,500
Flare Gas Recovery system	$4,864,000
Flare	$3,553,000
Pipeway adjustment	$ 662,050
Subtotal	**$13,229,550**
Shipping	$ 123,000
Sales Tax	$ 508,000
Engineering	$2,790,000
Contingency	$3,094,000
Total	**$19,744,550**

Staff updated the Jacobs Engineering estimate to 2005 dollars by adjusting the costs for inflation. Staff looked at a number of annual inflation measures, as set forth in Table 7.2. Staff ultimately used an average of 1.39% to convert to 2005 dollars.

Table 7.2
Various Inflation Adjustment Factors: 1993 to 2005

Bureau of Labor Statistics Consumer Price Index [12]	1.38
Solomon & Associates Plant Replacement Value[13]	1.26
Turner Construction Cost Index[14]	1.54
Average Inflation Factor	**1.39**

Adjusted for inflation, the Jacobs Engineering estimate for a flare system capable of handling 50 PRDs is $27.5 million in 2005 dollars, with a plus or minus 30 percent confidence range of $19.2 million to $35.7 million in 2005 dollars.

Given the age of the Jacobs Engineering estimate, staff also compared the estimate with current construction and materials costs to assess whether the estimate, adjusted for inflation, continues to provide a reliable picture of what it would actually cost to install a flare system today. Staff contacted contractors with experience in design and construction of flare systems, as well as affected facilities that have recently installed flares and/or similar equipment. In some cases, these contacts were able to review the Jacobs Engineering study and provide an overall opinion on whether the methodology was generally valid and whether the cost inputs used, adjusted for inflation, generally reflect current realities. In other cases, they were able to give current cost data for individual components of a flare system (including labor and/or materials), which allowed

District staff to compare the Jacobs Engineering estimate with current realities on a line-item by line-item basis. Several examples demonstrate how these inquiries served to validate the Jacobs Engineering estimates.

- *Flare, Knockout Drum, and Water Seal:*

Staff first compared the Jacobs Engineering estimates for the various materials and equipment needed for a flare system with the current costs for such items. Staff contacted John Zink, Inc., a flare manufacturing contractor, who provided current cost information for a 200-foot self supported flare, a knockout drum built right into the bottom of the flare base, and a water seal. The company estimated that this equipment would cost roughly $500,000 today.(15) This estimate corresponds very closely with the Jacobs Engineering estimate, which comes to $505,960 (in 2005 dollars) for a flare, knockout drum, and water seal.

- *Thermal Incinerator*

Staff also examined cost estimates published by the United States Environmental Protection Agency ("US EPA") for a thermal incinerator and associated piping.(16) A thermal incinerator is a control device that combusts hydrocarbon vapors before they are emitted to the atmosphere in a manner similar to a flare. This similarity makes it a good comparator to a flare. EPA estimates that the cost of the thermal incinerator itself (without the lines to connect it to the PRDs and all of the other parts of the complete system) would cost between $25 and $90 per standard cubic foot per minute (scfm) of capacity. For a 60,000 scfm system that could handle 50 PRDs – the capacity used in the Jacobs Engineering estimate – the total cost would be $1,500,000 to $5,400,000. The analogous Jacobs Engineering estimate for the flare equipment is $3,633,500 (in 2005 dollars), which is squarely within the range of EPA's estimate.

- *Piping:*

Staff also examined the costs of installing piping to carry PRD emissions to the flare system, which is another large portion of the costs of a new flare system. Staff examined the piping costs that the Tesoro refinery incurred when they had two releases within five years and had to pipe certain PRDs to a control system under Section 8-28-304.2 of the current rule. In Tesoro's experience, it cost approximately $30,000 to $32,500 per 100 linear feet of pipe.(17) This is slightly higher than the Jacobs Engineering piping estimate, which ranged from $9,750 to $24,310 in 2005 dollars, but is well within an order of magnitude. Again, this recent experience corresponds well with the estimates drawn from the work Jacobs Engineering did in connection with the 1997 Amendments.

- *Labor Inputs:*

To examine whether the estimates of labor inputs that Jacobs Engineering used are accurate, Staff contacted Rex Kenyon & Associates, a maintenance consulting services company. Kenyon provided labor estimates for a large number of particular tasks that would be involved in installing a flare system. Kenyon has generated these estimates from trades estimating manuals, and has compiled them into Excel spreadsheet estimating tool which District staff used to

compare the Kenyon estimates of current labor inputs with the Jacobs Engineering estimates.[18] Staff identified 32 tasks included in the Jacobs Engineering Estimate that had direct comparators in the Kenyon estimates. Of these 32 common tasks, the Jacobs estimate was lower for 20 of them (ranging from 39% to 96% of the Kenyon estimates) and higher for 11 of them (ranging from 111% to 229% of the Kenyon estimates), with 1 task being exactly the same. This comparison shows that the labor estimates that Jacobs Engineering used continue to be valid today for estimating the costs involved in installing a new flare system.

Given this close correlation between the cost inputs used in the Jacobs Engineering estimate (as adjusted for inflation) and current costs for similar inputs, Staff believe that the Jacobs Engineering cost estimate, adjusted for inflation, provides a reliable estimate of what it would cost to install a new flare system today.

Shell Estimate:

The District also examined an estimate prepared by Shell for installing a new flare to handle PRD emissions at its refinery in Martinez. Shell prepared this estimate pursuant to Section 8-28-304.1 of the Rule, which requires facilities to analyze the cost-effectiveness of controlling PRDs that experience release events. In connection with this requirement, Shell examined the costs of installing a new flare, liquid knockout drum, flare gas recovery, major headers, and individual sub-headers servicing individual PRDs. Shell estimated that it would cost the refinery $50 million for a system that could serve 39 PRDs in one area of the refinery and $25 million for a system that could serve 10 PRDs in another area of the refinery. Shell estimated that it would need two separate flare systems because the relatively long distance between the two areas and the relatively low design pressures involved made it unreasonable to expect that a single flare system could serve both areas.[19]

This estimate is slightly higher than the Jacobs Engineering estimate of $27.5 million (in 2005 dollars) for a system capable of handling 50 PRDs, but it is within a factor of two of that estimate.

Costs to Control All PRDs District-Wide:

Staff then used the estimates referenced above to estimate what it would cost to control all PRDs District-wide. Using the more conservative estimate of $27.5 million for a system to handle 50 PRDs, Staff then looked at how many new flare systems would be needed to control all 324 PRDs currently in atmospheric service around the Bay Area. Staff assumed that one new flare system with a capacity to handle 50 PRDs would be sufficient to control the PRDs at three of the refineries, and that two new flare systems would be required at each of the remaining two refineries because they have around 100 PRDs each. Staff therefore estimated that seven new flare systems would be needed in total to

control the PRDs at all five refineries.[x] These calculations are summarized in Table 7.4.

Table 7.4
Flare Systems Required to Control PRDs at the Five Bay Area Refineries

Refinery	Atmospheric PRDs	Additional Flare Systems Needed
Chevron-Texaco	41	1
ConocoPhillips	12	1
Shell	107	2
Tesoro	99	2
Valero	65	1
Totals	**324**	**7**

At approximately $27.5 million per flare system, controlling all 324 PRDs with flares would thus result in a total capital cost of approximately $192.5 million District-wide. As with any estimate, there is some uncertainty inherent in this number. Staff is confident that it is reasonably accurate, however, and certainly is accurate to within an order of magnitude.

Costs of Using Existing Control Systems:

Staff also examined the costs of piping existing atmospheric PRDs to existing control systems. As noted above, it is highly unrealistic to assume that there is currently excess capacity to handle all 324 PRDs throughout the District: PRDs are designed to release large volumes of material in a short period of time, and control systems need to be capable of handling combined emissions from many PRDs simultaneously in case of an upset involving multiple units. Furthermore, to the extent that there is existing excess capacity, the current rule contemplates that any such existing excess capacity would be reserved for handling "bad actor" PRDs that have repeat releases and trigger the control requirements. It would be preferable to target any existing excess capacity to these PRDs, rather than use it for PRDs that may have a very low potential for release. Staff therefore believes that although there is most likely some spare capacity, it is unrealistic to assume that all existing PRDs can be vented to existing control systems. Staff have nevertheless analyzed the costs of controlling all existing PRDs assuming that sufficient spare capacity exists as an ultra-conservative estimate of the very least it could possibly cost to control all existing PRDs.

[x] There is a certain level of approximation inherent in these calculations, because PRDs do not exist at facilities in neat multiples of 50. Staff believes that such approximation is appropriate, however, because the experience of refineries with fewer than 50 PRDs – which will be able to install a smaller flare system and incur fewer costs – will balance out the experience of facilities that have more than 50 PRDs and will require a larger flare system at greater cost. Notably, the two refineries that staff estimate will need two flare systems have very close to 100 PRDs each (99 and 107), almost exactly double the 50 PRDs that staff used as the basis for their cost estimate. Staff therefore believes that their assumptions are supportable and appropriate for this cost estimation exercise.

Staff first examined the experience of one refinery that was able to reroute emissions from 8 PRDs back into its process unit in a closed loop, without having to send them to a flare or vapor recovery system. The refinery was able to do so because unlike most PRDs, the devices involved served a liquid-packed unit, which (unlike gaseous equipment) can alleviate an overpressure without having to vent a lot of material. The refinery found that it could pipe the PRDs to a knockout drum to recover liquids vented from the PRDs, and then vent the relatively small amount of remaining vapors back into the system without risking any over-pressure problems. The refinery was able to accomplish this modification at a cost of $2 million for 8 PRDs.[20] Extrapolating this experience District-wide – which is not a reasonable assumption given that only a small subset of PRDs is likely to be eligible for such treatment – the cost would be $81 million for all 324 PRDs.

Staff also reviewed an estimate by another refinery for piping PRDs to existing control capacity, which was prepared pursuant to Section 8-28-304.1 of the current rule. The refinery estimated that it would be able to vent an individual PRD to an existing flare system at a cost of $75,000.[21] The refinery noted that existing spare capacity was limited, making it unreasonable to assume that all PRDs could be treated this way. Assuming they all could, however, this estimate would translate into a District-wide cost of $24.3 million for all 324 existing atmospheric PRDs.

Assuming there was existing capacity for all PRDs District-wide, the only costs that facilities would incur would be the cost of installing piping to carry emissions from the PRD to the control device. Based on the estimates outlined above of $9,750 to $32,500 for 100 linear feet of piping per PRD, which was the average length of piping used in the Jacobs Engineering analysis, the costs of piping alone would be approximately $1.6 million to $5.3 million for 50 PRDs. For the 324 atmospheric PRDs District-wide, this corresponds to a total cost of $10.5 million to $34.8 million.

Based on these estimates, Staff has concluded that even if facilities had existing capacity to control all existing atmospheric PRDs, it would still cost $10.5 million to $81 million to control all PRDs District-wide. Again, staff does not believe that this is a realistic estimate given that it is highly unlikely that facilities have sufficient existing capacity for 324 PRDs.

Cost Effectiveness:

Based on the cost estimates of the various control scenarios outlined above, and the emissions reductions that would be expected from each of them, staff has calculated the cost-effectiveness of each option. Staff amortized the costs over a 10 and 20-year period at seven percent to determine the annualized costs. Staff then compared the annualized costs with the anticipated annual emissions

reductions based on the 17.9 tons-per-year emissions average since 1998 and based on the lower 8.6 tons-per-year average since the Prevention Measures requirements took effect. The results of these calculations are set forth below.

Cost-Effectiveness If New Control Systems Required:

For new flare systems to control all existing atmospheric PRDs, the cost-effectiveness calculations are as follows.

Estimated total cost District-wide: $192.5 million
Cost annualized over 10 years: $26.8 million per year
Cost annualized over 20 years: $17.9 million per year

Estimated emissions reduction efficiency: 98%
Tons of reductions from 17.9 tons-per-year baseline: 17.5 tons per year
Tons of reductions from 8.6 tons-per-year baseline: 8.4 tons per year

Based on these calculations, the cost-effectiveness of flare systems under different scenarios is set forth in Table 7.5.

Table 7.5
Cost Effectiveness Calculations for New Control Systems

Annualization Period	Cost-Effectiveness Based on 17.9 tpy of emissions	Cost-Effectiveness Based on 8.6 tpy of emissions
10 years	$1.5 million per ton	$3.2 million per ton
20 years	$1.0 million per ton	$2.1 million per ton

Cost-Effectiveness Assuming Existing Spare Control Capacity:

If there were existing flare or vapor-recovery capacity to handle all existing atmospheric PRDs, and all that was needed was piping from the PRDs to the existing flares or vapor recovery systems, the cost-effectiveness calculations are as follows.

Estimated total cost District-wide: $10.5 million - $81 million
Cost annualized over 10 years: $1.5 million - $11.4 million per year
Cost annualized over 20 years: $977,000 - $7.6 million per year

Estimated emissions reduction efficiency: 98%
Tons of reductions from 17.9 tons-per-year baseline: 17.5 tons per year
Tons of reductions from 8.6 tons-per-year baseline: 8.4 tons per year

Based on these calculations, the cost-effectiveness of simply piping PRD emissions to existing flare or vapor-recovery capacity, assuming such capacity is available, is set forth in Table 7.6 for the different scenarios evaluated.

Table 7.6
Cost Effectiveness Calculations Assuming Existing Spare Capacity

Annualization Period	Cost-Effectiveness Based on 17.9 tpy of emissions	Cost-Effectiveness Based on 8.6 tpy of emissions
10 year	$86,000 - $650,000 per ton	$190,000 - $1.36 million per ton
20 year	$56,000 - $434,000 per ton	$127,000 - $905,000 per ton

In each of these cases, the costs associated with controlling all existing atmospheric PRDs would be far higher than what the District normally considers to be cost-effective. To give some perspective, the costs associated with the 1997 amendments were estimated to be $20,000 per ton of VOC emissions, which is at the high end of cost effectiveness for District regulatory proposals. Because of the very high cost, staff is not recommending that all PRDs be required to be piped to control systems.

B. Incremental Cost Effectiveness

Under California Health and Safety Code Section 40920.6, the District is required to perform an incremental cost analysis for a proposed rule under certain circumstances. To perform this analysis, the District must (1) identify one or more control options achieving the emissions reduction objectives for the proposed rule, (2) determine the cost effectiveness for each option, and (3) calculate the incremental cost effectiveness for each option. To determine incremental costs, the District must calculate the difference in the dollar costs divided by the difference in emission reduction potentials between each progressively more stringent control option as compared to the next less expensive option.

As explained above, staff examined two options in connection with the proposed amendments: an option to enhance the clarity and enforceability of the current rule, and an option to require all existing PRDs to be controlled. The first option would require facilities to demonstrate that they have the ability to detect release events and report them as required by the rule, which staff estimates will cost $65,300. Amortized over 10 or 20 years, this cost comes to approximately $9,300 or $6,200 in annualized costs, District-wide. The second option would require all PRDs to be controlled, and would cost between $26.8 million a year (annualized over 10 years) or $17.9 million (annualized over 20 years), assuming new control systems would be required. The incremental difference in

annualized costs would therefore be $26.8 million or $17.9 million, depending on which amortization period is used.

It is difficult to estimate the emissions reductions associated with monitoring and reporting requirements because they do not directly lead to emissions reductions. At the same time, comprehensive monitoring and reporting are necessary to ensure adequate compliance with the rule, so these requirements are essential to all the reductions expected from a regulation. Staff recognizes these inherent difficulties in analyzing the cost-effectiveness of such requirements, but has nevertheless estimated a 5% emissions reduction factor from these requirements. A 5% reduction would generate 0.9 tons per year in emissions reductions if the 17.9 tons-per-year baseline is used, or 0.43 tons per year if the 8.6 tons-per-year baseline is used. The emissions reductions that could be achieved by controlling all PRDs would be 17.5 tons or 8.4 tons, depending on which baseline is used. The incremental difference in emissions reductions would therefore be 16.6 tons or 8.0 tons depending on which baseline is used.

Based on these incremental emissions reductions and incremental costs, the incremental cost-effectiveness of the second option would be $1.08 million - $1.61 million per ton if the 17.9 ton emissions baseline is used, or $2.24 - $3.35 million per ton if the 8.6 ton baseline is used.

Under the unlikely scenario that no additional control systems would be required, the same calculations generate an incremental cost-effectiveness of $58,400 - $687,000 per ton if the 17.9 ton emissions baseline is used, and $121,000 - $1.43 million per ton if the 8.6 ton baseline is used.

C. Socioeconomic Impacts

Section 40728.5 of the Health and Safety Code requires an air district to assess the socioeconomic impacts of the adoption, amendment, or repeal of a rule if the rule is one that "will significantly affect air quality or emissions limitations." Applied Economic Development of Berkeley, California has prepared a socioeconomic analysis. The analysis concludes that the affected facilities should be able to absorb the costs of compliance with the proposed rule without significant economic dislocation or loss of jobs. The socioeconomic analysis is attached as Appendix A.

VIII. ENVIRONMENTAL IMPACTS

Pursuant to the California Environmental Quality Act, the District has had an initial study for the proposed amendments prepared by Environmental Audit, Inc. The initial study indicated there are no potential significant adverse environmental impacts associated with the proposed amendments. The District intends to file a negative declaration for the proposed amendments to this rule.

IX. REGULATORY IMPACTS

California Health and Safety Code Section 40727.2 requires the District to identify existing federal air pollution control requirements for the equipment or source type affected by the proposed rule or regulation. The District must then note any differences between these existing requirements and the requirements imposed by the proposal. Regulation 8, Rule 28: Episodic Releases from Pressure Relief Devices at Petroleum Refineries and Chemical Plants applies to emissions from atmospheric pressure relief devices located at refineries and chemical plants. The proposal does not expand the applicability or the current rule. No federal air pollution control requirement or other District rule regulates episodic emissions from pressure relief devices.

X. RULE DEVELOPMENT PROCESS

In developing the proposed amendments to Rule 8-28, District Staff went through an extensive rule development process to solicit and receive input from affected facilities, interested organizations, and other members of the public. This section summarizes that work.

A. PRD Audit – May, 2002

Staff's rule development efforts commenced with a detailed examination of the current rule. Staff began by conducting an audit of PRDs at all five petroleum refineries in the Bay Area to investigate whether those facilities have been detecting and reporting PRD releases as required by the Rule. The audit did not find any definitive evidence of reportable releases (over 10 pounds) that had gone undetected or unreported. Staff could not conclude that all reportable releases have been detected, however, because the refineries did not have comprehensive data available for many of their PRDs, either because they do not monitor the PRDs or because they do not maintain data for any length of time. Indeed, staff discovered several small releases of which the facility was not aware. These involved less than 10 pounds of material so they are exempt from the Rule and would not have had to be reported, but they highlight the possibility that reportable releases could have gone undetected as well. Staff concluded from this review that the potential exists for reportable releases to go undetected by refinery operators, and recommended that Regulation 8-28 should contain explicit monitoring and recordkeeping requirements to alleviate this problem.

B. Technical Assessment Document – December 2002

Staff then conducted a technical assessment of the current Rule that assessed options for further improvements. The resulting Technical Assessment Document ("TAD") echoed the findings of the PRD Audit that facilities are not monitoring all of their PRDs sufficiently to ensure that any reportable release is detected and reported to the District. The TAD recommended that an explicit

monitoring requirement be added to the rule to ensure that all releases can be detected and quantified, among other ideas.

C. Technical Workgroup Meeting – May 9, 2005

Staff next convened a public workgroup meeting to discuss the findings of the Rule Audit and Technical Assessment Document and potential improvements to the rule. The workgroup meeting was held on May 9, 2005, at the District's offices, and was attended by representatives of the five Bay Area refineries, the Western States Petroleum Association ("WSPA"), and Communities for a Better Environment ("CBE"), as well as by staff of the District and the California Air Resources Board. The workgroup discussed the following regulatory concepts:

- Clarification of the term "source" as used in the rule. Representatives of WSPA and the refineries suggested that "source" should be limited to pressure-related equipment, while representatives of CBE suggested that "source" should be defined to include any equipment that could be affected by a process upset, even if it is not pressure-related.
- Making explicit the duty to monitor for PRD releases. All parties were in general agreement that the rule should explicitly require monitoring to detect and characterize PRD releases. Representatives of CBE contended that current monitoring systems are deficient and that the refineries' reported information on releases underestimates actual emissions. Representatives of the refineries contended that current monitoring is sufficient to detect all releases, but agreed that further improvements could be made.
- Requiring telltale indicators on all PRDs. Representatives of WSPA and the refineries contended that pressure monitoring systems are preferable to telltale indicators as methods to detect and quantify releases. They suggested that facilities be given a choice to use telltale indicators or pressure monitors, instead of allowing pressure monitors only where telltale indicators are infeasible.
- Requiring additional controls on PRDs, beyond what is already required by the Rule. Representatives of CBE suggested that the District should require all PRDs to be piped to control systems, and that the District should at least go back and review its previous analyses on what level of controls should be required to determine if its earlier conclusions are still valid.
- Removal of obsolete provisions and other minor non-substantive amendments.

D. Public Workshop Meeting – September 14, 2005

Staff then took this input and developed a draft of the proposed rule amendments, along with a draft staff report. Staff disseminated these documents among interested parties and the public, and then convened an early-evening public workshop meeting in Rodeo, Contra Costa County, to receive public input on them. The meeting was attended by representatives of the refineries, WSPA, Dow Chemical, CBE, the Contra Costa County Health Services Department, and the District, as well as a number of interested individuals. The discussion focused on the following principal areas.

- Success of current approach. Representatives of WSPA noted that the current version of the rule has worked well in reducing the frequency and severity of PRD releases.
- Definition of "source". Representatives of CBE again commented that "source" should not be limited to pressure-related equipment, but should include all equipment in a given process unit. They claimed that this was the intent of the current version of the rule, and that limiting "source" to pressure-related equipment would amount to backsliding.
- Additional control requirements. Representatives of CBE and several members of the public suggested that the District should require all PRDs to be piped to controls. Representatives of CBE commented that such a requirement would be cost-effective, and suggested that staff need to conduct further analysis on that issue. They and other commenters also stated that all PRDs should be controlled regardless of costs. Representatives of CBE claimed that the "Precautionary Principle" states that all feasible pollution prevention measures should be implemented regardless of the costs and that application of that principle here would require controls on all PRDs. Several commenters suggested that a blanket control requirement could be made less onerous by phasing it in over a long lead time.
- Acutely hazardous materials. Representatives of CBE stated that staff should consider requiring controls on all PRDs to reduce the likelihood of a catastrophic release of acutely hazardous materials that could affect workers and nearby residents. They stated that allowing any PRDs to vent to the atmosphere presents an unacceptable risk.
- Fugitive emissions. Representatives of CBE commented that staff needs to consider the potential for reduced fugitive emissions (leaks) from PRDs that would result from requiring all PRDs to be controlled. They commented that this is an additional benefit to a blanket control requirement that staff needs to consider.

At the conclusion of the meeting staff also invited the public to submit written comments on the draft rule and staff report, and several entities did so.

E. Informal Office Meetings with Interested Parties – September 2005

Staff also met individually during this time period (immediately before and after the public workshop) with representatives from the refineries and WSPA, CBE, Contra Costa County Health Services Department, and Dow Chemical to discuss the proposed regulations. Following up on these meetings, each of these entities (except Dow Chemical) also submitted written comments on the public workshop draft summarizing their positions.

F. Further Technical Workgroup Meeting – October 20, 2005

Staff also held a further technical workgroup meeting to discuss additional cost-effectiveness information on which Staff wanted to receive input. Staff also sought additional input on how the term "source" should be defined, and on how to specify minimum requirements for monitoring systems for PRD releases. Some participants also voiced a desire to have the District prohibit the use of atmospheric PRDs altogether.

G. Changes to the Proposal in Response to Public Input

In response to the public input received during this process, Staff took further action in several areas, including the following.

- Telltale indicators and monitoring: Several parties suggested that pressure monitoring systems are better than telltale indicators in many instances. Staff agrees with these commenters, and has removed the preference for telltale indicators that it initially proposed. The current proposal would allow affected facilities to choose whichever system of monitoring they deem most appropriate, as long as it meets the standards set forth in Section 8-28-503. In addition, Staff has made the monitoring requirement more generic so that it can accommodate situations where pressure is not the principal indicator of whether the PRD has released and if so how much material was involved. Any monitoring system will require a demonstration (in a report to the District) of its ability to effectively monitor PRD releases.
- "Source" Definition. Staff initially proposed that "source" be defined as all equipment within a pressure-related system. Commenters pointed out that the intent of the current rule is that "source" is a broader term encompassing all equipment within a given process unit, because of the potential for a process upset leading to a PRD release is not limited to a particular pressure-related systems within a process unit. Staff researched the intent of the current rule further and determined that this is correct. Staff reviewed the rationale behind the intent of the current rule and believes that it is sound from a technical and policy perspective, and so has changed its proposal. Staff now proposes to define "source" as a

process unit, the definition that was intended in the 1997 amendments and has added a definition of "process unit" to clarify the intent of the rule.

- Further cost analysis. In response to comments that staff should re-evaluate the costs and benefits of piping all PRDs to control systems, staff conducted additional cost analysis, and done additional work to verify costs used for the 1997 amendments. Staff contacted major engineering firms to estimate costs from piping and controls regarding the Jacobs Engineering report prepared in connection with the 1997 amendments and found that the costs, as adjusted for inflation to 2005 dollar values, are valid. Engineering firms contacted to validate costs are listed in the Reference Section at the end of this staff report.
- Further catastrophic release analysis. In response to comments that staff should consider provisions directed at preventing catastrophic releases of acutely hazardous materials, staff has reviewed the existing requirements and the work of the Board's Ad Hoc Committee on Accidental Releases in the 1990s. There are numerous federal, state and local ordinances that create programs to plan, prevent and mitigate accidents and releases of materials as a result of accidents. The District has been involved in the development of these programs for various Bay Area facilities, including refineries. Of note is the Contra Costa County Industrial Safety Ordinance (ISO), adopted in 1998. The ISO requires process hazards analyses, implementation of action items from those analyses, review of prevention measures and root cause analyses when accidents occur, strengthening existing review, inspection, auditing, and safety requirements, including public input on results of inspections and audits, and expansion of federal and state programs to additional industrial processes. These issues are addressed in detail in Section IV.B of the Staff Report.
- Fugitive Emissions. Comments suggested that staff should assess fugitive emissions from PRDs. Fugitive emissions from leaks at pressure relief devices were estimated to be 3300 pounds (1.65 tons) per day in 1997. Because of the requirements in Rule 8-28 and in Rule 8-18: Equipment Leaks, inspection programs and stricter standards imposed since 1997 have reduced emissions to approximately 10 pounds per day.

Detailed responses to all of the comments received -in response to the public hearing notice and final draft rule are provided in Appendix B.

XI. CONCLUSIONS

The 1997 amendments to Regulation 8, Rule 28 have been successful in preventing releases, reducing emissions, and requiring control of those pressure relief devices that need it most. The rule has required refiners to consider these releases and integrate control technologies into their future plant modifications.

The proposed amendments to Regulation 8, Rule 28 meet the commitment made as part of 2001 Ozone Attainment Plan Further Study Measure 8. The proposed amendments will enhance the District's ability to enforce the rule and enhance the operator's ability to detect releases. The proposed amendments also clarify the rule so that it can be more easily understood.

Pursuant to the California Health and Safety Code Section 40727, before adopting, amending, or repealing a rule the Board must make findings of necessity, authority, clarity, consistency, non-duplication and reference. The proposed regulation is:

- Necessary to supplement the District's ability to enforce the regulation and ensure that all provisions in the regulation are complied with;
- Authorized by California Health and Safety Code Section 40702;
- Clear, in that the new regulation specifically delineates the affected industries, compliance options and administrative and monitoring requirements for industry subject to this rule,
- Consistent with other District rules, and not in conflict with state or federal law,
- Non-duplicative of other statutes, rules or regulations, and
- The proposed regulation properly references the applicable District rules and test methods and does not reference other existing law.

A socioeconomic analysis prepared by Applied Development Economics has found that the proposed amendments would not have a significant economic impact or cause regional job loss. A California Environmental Quality Act analysis prepared by Environmental Audit, Inc., concludes that the proposed amendments would not result in any adverse environmental impacts. A Negative Declaration for the proposed amendments has been prepared and was circulated for comment. All public noticing requirements for adoption of this rule have been met.

Staff recommends the adoption of the proposed amendments to Regulation 8, Rule 28: Episodic Releases from Pressure Relief Devices at Petroleum Refineries and Chemical Plants, and approval of a CEQA Negative Declaration.

XII REFERENCES

[1] Crosby® Pressure Relief Valve Engineering Handbook, Technical Document No. TP-V300, May 1997.

[2] Crosby® Series Technical Brochure: JOS-E, JBS-E, JLT-JPS-E, JLT-JBS-E, JOS-H-E; Spring Loaded Pressure Relief Valves; 2005

[3] Testimony of Mr. Jim Karas, BAAQMD Air Quality Engineering Manager, Meeting of BAAQMD Ad Hoc Committee on Accidental Releases, October 26, 1995.

[4] Final Staff Report, Control of Episodic Releases Of VOCs From Pressure Relief Devices at Petroleum Refineries, Dec. 9, 1997, p. 30.

[5] Testimony of Mr. Barry Young, Principal Air Quality Engineer, Public Meeting of the BAAQMD Board of Directors, Dec. 9, 1997.

[6] Final Staff Report, Control of Episodic Releases of VOCs from Pressure Relief Devices at Petroleum Refineries, December 9, 1997, page 11.

[7] Kathy Wheeler, Shell – Telephone conversation with District staff, June 1, 2005.

[8] Lisa Polos, ConocoPhillips – Telephone conversation with District staff, June 2, 2005.

[9] Omega Engineering, Inc. – Telephone conversation with District staff, June 1, 2005.

[10] John Parker, Accutech Industrial Solutions – Presentation to District staff, June 21, 2005.

[11] Jacobs Engineering Group Inc., Pressure Valve Cost Study, prepared for Western States Pretroleum Ass'n, Concord, CA (July 1993).

[12] Bureau of Labor Statistics: Consumer Price Index for the San Francisco-Oakland-San Jose, CA Metropolitan Area: Series Id: CUURA422SA0, CUUSA422SA0.

[13] Solomon Associates: http://www.solomononline.com/.

[14] Turner Construction Company, Cost Index.

[15] Bob Ferraro, Regional Sales Manager, John Zink Company, Email, Subject: Order of Magnitude Cost Estimates for refinery relief systems; September 23, 2005.

[16] United States Environmental Protection Agency: "Air Pollution Control Technology Fact Sheet, Thermal Incineration, August 14, 2003; Document Number EPA-452/F-03-022.

[17] Mike DeLeon, Tesoro – Telephone conversation with District Staff, October 13, 2005.

[18] Cost Estimating Spreadsheet, Rex Kenyon & Associates (undated, provided Oct. 11, 2005).

[19] Atmospheric Relief Valve Cost Estimates, Shell Martinez Refinery (Rev. 5: February 2005)

[20] Mike DeLeon, Tesoro – Telephone conversation with District staff, May 26, 2005.

[21] Letter from Clark Hopper, Environmental Manager, Valero Refining Co., to Kelly Wee, Director Of Enforcement, BAAQMD, August 28, 2003, p. 3.